

REMARKS

By the present amendment, a substitute specification and replacement sheets of drawings are being submitted along with marked-up versions showing the changes made. Further, claims 1-8 and 10-12 have been amended in particular as follows:

- Claim 1 now recites that the longitudinally extending supports are mounted on ball and socket bearing supports by ball and socket bearings, said ball and socket bearing supports being mounted on the profile sections, the profile sections being fitted to be affixed perpendicularly onto the central core.
- Claim 2 now recites that the profile of the central core comprises at least one groove for laterally clamping suction pipes for the air chokes.
- Claim 3 now recites that the small plate is slidable along a groove of the central core.
- Claim 8 now recites that the gripper comprises an extension piece to be affixed between at least one of the profile sections and the corresponding ball and socket bearing support.
- Claim 10 now does not recite a manual interface.
- Claim 11 has now been canceled.

Support for the amendments to claims 1-8 and 10-12 is found in the original application, in particular in the figures.

Further, new claims 13-37 have been added in particular as follows:

- New claims 13-15 correspond to claims 5, 6, and 9 rewritten in independent form by incorporating therein the subject matter of claim 1.
- New claim 16 recites a central profile section core having a cross-section that remains substantially the same over their length and profile sections each having a cross-section that

remains substantially the same over its length.

- New claim 17 recites that the profile section has two longitudinal planes of symmetry substantially perpendicular to each other, and comprises two opposed lateral grooves having openings oriented along one of these planes of symmetry and two additional opposed lateral grooves having openings oriented along the other of these planes of symmetry, wherein each of the grooves has a maximum transverse width larger than a width of its opening.
- New claim 18 recites that the at least one profile section has at least one longitudinal plane of symmetry and a lateral groove having an opening along this plane of symmetry, the groove having a maximum transverse width larger than a width of its opening, and that the ball and socket bearing support is in the shape of an angle bracket which extends away from the plane of symmetry of the profile section.
- New claim 19 recites that the at least one profile section has at least one longitudinal plane of symmetry and a longitudinal groove having an opening along this plane of symmetry, the groove having a maximum transverse width larger than a width of its opening, and that a main central axis of the ball and socket bearing is oriented away from the plane of symmetry of the profile section, and the ball and socket bearing support is clamped to the profile section independently from the ball joint.
- New claims 20-37 depend on claims 2, 7, 9, 1, 23, 24, 1, 26, 27, 1, 1, 16, 17, 17, 18, 18, 19, and 19, respectively.

Support for the new claims is found in the original application, in particular in the figures.

As a preliminary, Applicant and Applicant's representative thank the Examiner for the personal interview which was held on January 8, 2004.

In the Office Action, claims 5, 6, and 9 are considered to contain allowable subject matter, and claim 12 is allowed.

Claims 13-15 correspond to claims 5, 6, and 9 rewritten in independent form as suggested in the Office Action. Accordingly, it is submitted that claims 12-15 are immediately allowable.

However, in the Office Action, claims 3, 10 and 11 are rejected under 35 U.S.C. 112, first paragraph, for lack of enablement.

Claim 3 has been amended to recite that the small plate is slidable along a groove of the central core, the reference to a manual interface in claim 10 has been deleted, and claim 11 has been canceled. Accordingly, it is submitted that the rejection should be withdrawn.

Next, in the Office Action, claims 1, 2, 4, 7 and 8 are rejected under 35 U.S.C. 102(b) as anticipated by US 4,957,318 to Blatt (Blatt).

Reconsideration and withdrawal of the rejection is respectfully requested. As discussed during the personal interview, Blatt mounts the air choke support to a mounting bracket 28 by ball and socket bearing, and the mounting bracket is attached directly on a central rod 26, as shown in the figures. Thus, Blatt is completely silent regarding (i) profile sections fitted in order to be affixed perpendicularly onto a central core, with mechanisms for affixing these profile sections at selected locations. (ii) ball and socket bearing supports mounted on the profile sections, and (iii) longitudinally extending supports mounted on ball and socket bearing supports by ball and socket bearings, as recited in present claim 1.

An advantage of this construction is that the use of the profile sections to be affixed to the core, and on which are mounted supports for the ball and socket bearings, makes it possible to improve modularity and extend the surface covered by the assembly. This feature and its

advantages are not taught or suggested in Blatt, and therefore, present claim 1 and the claims dependent thereon are not obvious over Blatt.

Similarly, with respect to claim 16, Blatt is also completely silent regarding (i) a central profile section core having a cross-section that remains substantially the same over their length, whose dimension is fitted to the size of the piece to be transported, (ii) profile sections each having a cross-section that remains substantially the same over its length, said profile sections being fitted in order to be affixed perpendicularly onto this central core, with mechanisms for affixing these profile sections at selected locations, and (iii) longitudinally extending supports mounted on these profile sections by ball and socket bearings.

An advantage of this construction is that the core as well as the profile sections can be cut from standard stock, for example, extruded or laminated beams of appropriate shape and size. This feature and its advantages are not taught or suggested in Blatt, and therefore, present claim 16 and the claims dependent thereon are not obvious over Blatt.

Further, with respect to claim 17, Blatt is also completely silent regarding (i) at least one profile section, (ii) longitudinally extending air chokes supports mounted on these profile sections by ball and socket bearings, wherein (iii) the profile section has two longitudinal planes of symmetry substantially perpendicular to each other, and comprises two opposed lateral grooves having openings oriented along one of these planes of symmetry and two additional opposed lateral grooves having openings oriented along the other of these planes of symmetry, wherein each of the grooves has a maximum transverse width larger than a width of its opening.

An advantage of this construction is that one pair of opposed grooves in the profile sections can be used to removably attach the supports for the air chokes and the other pair of opposed

grooves can be used to attach pressurized fluid conduits, as shown in the present application. This feature and its advantages are not taught or suggested in Blatt, and therefore, present claim 17 and the claims dependent thereon are not obvious over Blatt.

Further, with respect to claim 18, Blatt is also completely silent regarding (i) at least one profile section having at least one longitudinal plane of symmetry and a lateral groove having an opening along this plane of symmetry, the groove having a maximum transverse width larger than a width of its opening, (ii) a ball and socket bearing support mounted on the profile section, and (iii) wherein the ball and socket bearing support is in the shape of an angle bracket which extends away from the plane of symmetry of the profile section such that (a) a ball joint on the ball and socket bearing is placed away from the plane of symmetry of the profile section and (b) a main central axis of the ball joint on the ball and socket bearing is oriented away from the plane of symmetry of the profile section.

An advantage of this construction is that the shifting of the ball and socket bearing away from the plane of symmetry of the profile section combined with the orientation of the central axis of the ball joint away from that plane makes it possible to improve the positioning and the orientation of the air chokes away from the profile sections while ensuring sufficient rigidity of the construction and secure grasping of parts having various shapes. This feature and its advantages are not taught or suggested in Blatt, and therefore, present claim 18 and the claims dependent thereon are not obvious over Blatt.

Further, with respect to claim 19, Blatt is also completely silent regarding (i) at least one profile section having at least one longitudinal plane of symmetry and a longitudinal groove having an opening along this plane of symmetry, the groove having a maximum transverse width

larger than a width of its opening, a ball and socket bearing support mounted on the profile section, and (iii) wherein a main central axis of the ball and socket bearing is oriented away from the plane of symmetry of the profile section, and the ball and socket bearing support is clamped to the profile section independently from the ball joint.

An advantage of this construction is that the air choke supports can be positioned and oriented with respect to the ball and socket bearing supports independently from the positioning and orientation of the ball and socket bearing supports with respect to the profile sections, while providing improved orientation of the air chokes away from the profile sections. This feature and its advantages are not taught or suggested in Blatt, and therefore, present claim 19 and the claims dependent thereon are not obvious over Blatt.

In view of the above, it is submitted that the rejection should be withdrawn.

In conclusion, the invention as presently claimed is patentable. It is believed that the claims are in allowable condition and a notice to that effect is earnestly requested.

In the event there is, in the Examiner's opinion, any outstanding issue and such issue may be resolved by means of a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

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Serial Number: 10/058,075

Group Art Unit: 3652

In the event this paper is not considered to be timely filed, the Applicants hereby petition for an appropriate extension of the response period. Please charge the fee for such extension and any other fees which may be required to our Deposit Account No. 50-2866.

Respectfully submitted,

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Encls.: Substitute Specification w/Marked-Up Version

Replacement Drawings w/Marked-Up Version

Petition for Three-Month Extension of Time

RCE

Amendment Transmittal

## **Modular Gripper (MARKED-UP VERSION)**

The object of the invention presented here is a gripper provided with air chokes using vacuum suction, capable of transporting various materials or objects, in particular, made of metal, cardboard, glass, wood in all types of industries.

### **RELATED ART**

The manufacture of these grippers is generally performed in a non-industrial manner, differing according to the industrial environment, often out of welded steel tubes, always at the last minute, from a prototype of the piece to be transported, and designed by the maintenance departments of factories.

Grippers of this type are known, for example, from the patent FR-A 2 566 310 and from the patent EP 0 802 334. The standardization of these grippers is not a priority and is not the object of research as far as productivity is concerned.

### **SUMMARY OF THE INVENTION**

The gripper intended by the invention has the purpose of correcting these disadvantages.

According to the invention, the gripper has a modular structure, which comprises a central profile section core whose dimension is fitted to the size of the piece to be transported, and of profile sections fitted in order to be affixed perpendicularly onto this central core, mechanisms for affixing these profile sections at the selected location, ball and socket bearings mounted at the ends of these profile sections, air chokes that are affixed to the ends of the ball joints and ball joints that enable an angular clearance of the air chokes.

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Based on these characteristics, a prototype of the piece to be transported is no longer necessary, since the gripper can be designed from a digitized tape of the piece. The sizeable number of standard pieces makes it possible to assemble it in only about ten minutes by virtue of its modularity. In addition, adjustment can be done in three dimensions. In this way, it is possible to grip pieces having awkward and complex shapes.

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According to the invention, the gripper may also include the following characteristics. The central core may be profiled in such a way so as to make it possible to laterally clamp suction pipes for the air chokes. The mechanisms for affixing the profile sections to the central core may consist, for each profile section, of an angle bracket and a small plate that allow the profile sections to become affixed to any position of the central core. Each air choke may be supported by a ball joint mounted in a ball and socket bearing, giving the assembly a specified clearance, for example, of 22 degrees, thus making it possible to transport pieces having awkward shapes. The air choke may be supported by a combined ball joint mounted in a ball and socket bearing, giving the assembly an angular clearance of 30 degrees, and having different lengths that serve as the extension pieces. The air choke may be supported by a piece in the shape of a ball joint whose axis is mounted with a spring, and which is mounted in a ball and socket bearing, giving the assembly an angular clearance of 22 degrees.

Further, the gripper may comprise a ball and socket bearing fitted in order to mount the ball joints there and of ball joints that are fitted with springs as well as combined ball joints, thus making possible an angular clearance of approximately + 22 degrees in the two first cases, and of 30 degrees in the last case, where their attachment

onto the corresponding profile section makes it possible to make the assembly slide until the desired position along the profile section, or extension pieces and combined ball joints that make it possible for the air chokes to be able to suction by vacuum the pieces whose shapes or differences in height are sizeable. The gripper may comprise sloped shims that make it possible to increase the angle by 15 degrees in one case and 35 degrees in a second case. The gripper may be fitted in order to be affixed onto a robot or on a mechanized system by means of a manual interface, in order to allow an effective clamping of the gripper with a large amount of rigidity, or it may be adapted in order to be affixed onto a robot or on a mechanized system by automatic interfaces with a large amount of clamping rigidity. The gripper may be mounted onto a crosspiece that is itself mounted either onto a robot or onto a mechanized system, and that accommodates three interfaces that make it possible to mount a gripper to the center for small pieces to be transported, or to each end for the pieces that have large dimensions.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in reference to the attached drawings which show it in possible different embodiment modes.

Figure 1 is a perspective view of an embodiment form of a modular gripper according to the invention.

Figures 2 and 3 are transverse section views of the profile sections that can constitute a central core of the gripper according to the invention.

Figure 4 is a transverse section view of a profile section that can be attached perpendicularly to the central core of the gripper.

Figure 5 is a perspective view of a joint for attachment of a profile section to the central core.

Figure 6 is a perspective view of an angle bracket for attachment of a profile section to the central core.

Figure 7 is a perspective view of a ball and socket bearing support.

Figure 8 is a perspective view of a ball joint.

Figure 9 is a longitudinal section view of a ball joint fitted with a spring according to a second embodiment mode.

Figure 10 shows a ball and socket bearing equipped with an air choke.

Figures 11 and 12 show an extension piece and a sloped shim, respectively.

Figure 13 shows a small plate;

Figure 14 is a perspective view of the manual interface between the gripper and a robot or mechanized system (not shown).

Figure 15 is a sectional front view of a ball joint fitted with a spring, of its air choke and its bearing.

Figure 16 is a front view of a flat angle mounting bracket.

Figure 17 is a transverse section view of another profile section core 80 of the gripper.

Figure 18 is a perspective and partial section view of the profile section, of a ball and socket bearing, of a ball joint fitted with a spring, and the associated air choke.

Figure 19 is view similar to Figure 18 according to another embodiment form of the ball joint.

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Figure 20 is a front view similar to Figure 19 showing another embodiment variation.

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Figures 21 to 23 are perspective views of automatic interfaces between the modular gripper according to the invention and a robot or an automated system (not shown).

Figure 24 is a perspective view of a crosspiece equipped with three interfaces with grippers according to the invention.

Figure 25 is a front view of a ball joint combined with an extension piece.

Figures 26 and 27 show plates for arms bent at an angle vertically.

Figure 28 is a perspective view in a reduced scale of a gripper equipped with plates of Figures 26 and 27.

Figures 29 and 30 show plates for arms bent at an angle horizontally.

Figure 31 is a perspective view in a reduced scale of a gripper equipped with plates of Figures 29 and 30.

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#### DESCRIPTION OF PARTICULAR EMBODIMENTS

The gripper shown in the drawings is made of a modular structure, which includes a central profile section core 1 (Figs. 2 or 3) whose dimensions are fitted to the size of the piece to be transported, and of at least one profile section 2 (Fig. 4) fitted in order to be attached perpendicularly onto this central core 1.

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As shown on Figure 1, the central profile section core and the profile sections have cross-sections that remain substantially the same over their length.

As shown on Figures 2-4, the central profile section core and the profile sections each have two longitudinal planes of symmetry (respectively 10 and 11, 20 and 21, and

30 and 31), substantially perpendicular to each other, and comprises two opposed lateral grooves (respectively 12 and 13, 22 and 23, and 32 and 33) having openings oriented along one (respectively 10, 20, and 30) of these planes of symmetry and two additional opposed lateral grooves (respectively 14 and 15, 24 and 25, and 34 and 35) having openings oriented along the other (respectively 11, 21 and 31) of these planes of symmetry. As is visible in the Figures, each of the grooves has a maximum transverse width larger than a width of its opening.

The two lateral grooves 34, 35 of the profile section of Figure 4 make it possible to clamp there, on each side, a pipe, for example, of the size 5.5 x 8. The same possibility exists for opposed lateral grooves 14, 15 and 24, 25 of the profile sections of Figures 2 and 3, whose geometry can be modified approximately in order to allow the grooves to clamp, for example, 5.5 x 8 pipes there from two sides. The other grooves are for attaching air chokes as described in details below.

As shown on Figure 1, the gripper also includes mechanisms 3 for affixing these profile sections 2 at the selected locations, as well as ball and socket bearings 4 on supports 5 mounted on these profile sections 2 (see also Fig. 7 to 10), air chokes 6 that are affixed by air choke supports 7 to the ends of the ball joints (Fig. 10, 15, and 18-20) that enable an angular clearance of the air chokes.

The central core 1 can be made of aluminum. The attachment system 3 consists of a connection piece 3a (Fig. 5) and angle brackets 3b (Fig. 6); it makes it possible to easily adjust the different profile sections of Fig. 4 to the selected locations. The length of the profile sections of Fig. 4 is determined by the position of the air chokes 6 that, themselves, vary according to the geometry of the piece to be transported.

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At the end of the profile sections of Fig. 4, ball and socket bearings 4 are affixed through ball and socket bearing supports 5 (Fig. 7) on which simple ball joints 4a (Fig. 8) or ball joints 4a fitted with springs 4b (Fig. 9) or combined ball joints are mounted as needed. The mounting of all of the elements is shown in Figures 10, 15, 18 and 20. The ball and socket bearing supports (Fig. 7) are affixed onto the profile section of Fig. 4 by cooperating with small plates 5a (Fig. 13) that slide inside of the grooves of the profile sections by means of bolts 5b (Fig. 18), and which make thus it possible to provide a supplemental adjustment.

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As shown best in Figure 18, the ball and socket bearing support 5 in the shape of an angle bracket extends away from the horizontal plane of symmetry 20 of the profile section 2, such that (i) the ball joint 4a on the ball and socket bearing 4 is placed away from the plane of symmetry 20 of the profile section and (ii) a main central axis 70 of the ball joint on the ball and socket bearing 4 is oriented away from the plane of symmetry 20 of the profile section. Also, it is visible on Figure 18 that the ball and socket bearing support 5 is clamped to the profile section 2 independently from the ball joint 4a.

The two different types of ball joints (Fig. 8 and 9) make possible an angular clearance of approximately + 22 degrees, which makes it possible to refine the final adjustment. The combined ball joints (Fig. 25) allow an angular clearance of approximately + 30 degrees, and, depending on their length, act simultaneously as an extension 7a (Figs. 20, 25). The different types of air chokes are chosen as a function of the space available on the piece to be transported and its weight. There are affixed to the end of the ball joints (Fig. 10, 15 and 18-20).

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In case it is necessary to adjust the height, there are several types of extension pieces 8 (Figs. 1, 11) or combined ball joints covering most of the necessary adjustments. In case of awkward pieces that require an angular clearance greater than the one obtained with the ball and socket bearings (Fig. 7) and the ball joints (Fig. 8, 9), as well as the combined ball joints, sloped shims 9 are planned (Fig. 1, 12) that make it possible to increase the angle by 15 degrees in one case and 35 degrees in the other case.

The assembly of all of these pieces makes it possible to construct a modular gripper that is capable of meeting all requirements. The specifically designed shapes of the profile sections, as well as the standard assembly of the pieces made of a light metal alloy, make it possible to obtain an assembly having a large amount of rigidity with a relatively low weight. On the three types of profile sections, shapes have been specifically designed in order to clamp two types of suction pipe, which produce a gain in assembly time, and which make it unnecessary to affix them with pipe-collars. All three have been designed in order to receive the small mounting plate (Fig. 13), which makes it possible to only keep in stock a single small plate reference item, and to obtain a good quality of clamping in the profile sections. The inside hole respectively 16, 26, 36 of the profile sections of Figures 2-4 is designed in a manner to be directly threaded in ISO pitches without the necessity for machining.

The modular gripper according to the invention can be affixed onto a robot or onto a mechanized system with the help of a manual interface 50 that is specially adapted for this purpose (Fig. 14) for the profile sections of Figures 2-4. It is also possible to make automatic interfaces 51a and 51b for the profile section of Figure 2 (Figs. 21-22), and 51c for the profile section of Figure 3 (Fig. 23).

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The interfaces, by virtue of their monostable clamping at a corner cam of the profile section, allow in all cases a large amount of clamping rigidity and a good repeatability of the positioning precision of the modular gripper.

The profile section made of aluminum in Figures 2-4 has a structure whose shapes have been specifically designed in order to obtain an especially low weight, all while preserving an especially good resistance to torsion and to deflection. Moreover, on two opposite sides of the profile section of Fig. 2, the diameter of the shapes and the width of the intake groove provide the possibility for clamping on one side, a 5.5 x 8 suction pipe, and on the other side, a 4 x 6 suction pipe.

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In addition, on the two other sides, the shapes of the slides make it possible to mount the small mounting plates (Fig. 13) which are common to the profile section of Fig. 3 and to the profile section of Fig. 4. This has the consequence that only a single small plate reference item needs to be kept in stock (Fig. 13) and that a good clamping coupling is obtained since a good installation of the screw is made. The diameter of the inside hole of the profile section is provided in order to be tapped directly without additional drilling.

The different attachment pieces (connection piece of Fig. 5, angle bracket of Fig. 6, small plate of Fig. 13) make it possible for the profile section of Fig. 4 to attach at any position selected along the central core, comprised of the profile section of Fig. 2 or of the one from Fig. 3. The air choke is supported by a piece in the form of a ball joint (Fig. 8) that, once mounted in the ball and socket bearing (Fig. 7), gives the assembly an angular clearance of + 22 degrees, thus making it possible to transport pieces with awkward shapes and to refine the adjustments at the last minute (Fig. 10).



The extension pieces (Fig. 11) allow the air chokes to be able to suction by vacuum pieces whose shapes or differences height are sizeable. The automatic interface of Fig. 21 is provided for the section of Fig. 2, while the automatic interface of Fig. 22 is provided for the section of Fig. 3 and the automatic interface of Fig. 23 is provided for the section of Fig. 4.

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The design of these interfaces makes possible an effective clamping of the modular gripper by irreversible cam clamping and thus a large amount of clamping rigidity. Moreover, it ensures a good repeatability of the mounting precision, because the clamping is done on the sections, enabling an interchangeability of the grippers in a few seconds.

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The modular gripper can be mounted on a crosspiece 52 (Fig. 24) that itself is mounted either onto a robot or onto a mechanized system. This crosspiece accommodates three interfaces 53 specified according to the requirements. This system makes it possible to mount a gripper in the center when small pieces are to be transported, or one to each end for pieces having large dimensions. The specifically designed shapes of the crosspiece allow it to be light while maintaining a good rigidity and while limiting vibrations.

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Figures 26-27 show plates 61, 62 or arms bent horizontally that can equip a gripper (Fig. 28). They make it possible to split the central core of the gripper by 60 degrees. They are assembled in a pair: one in the groove of a profile section 4/6 and the other in that of 6/8.

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Figures 29-30 show plates 63, 64 for arms bent vertically. These plates, according to their height, function to move the gripper of the piece to be transported in

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the direction of the height (Fig. 31). Figure 31 also shows one air choke 6 mounted on a secondary profile section 80 affixed perpendicularly onto one of the profile sections 2 through mechanism 81.

## **Modular Gripper**

The object of the invention presented here is a gripper provided with air chokes using vacuum suction, capable of transporting various materials or objects, in particular, made of metal, cardboard, glass, wood in all types of industries.

### **RELATED ART**

The manufacture of these grippers is generally performed in a non-industrial manner, differing according to the industrial environment, often out of welded steel tubes, always at the last minute, from a prototype of the piece to be transported, and designed by the maintenance departments of factories.

Grippers of this type are known, for example, from the patent FR-A 2 566 310 and from the patent EP 0 802 334. The standardization of these grippers is not a priority and is not the object of research as far as productivity is concerned.

### **SUMMARY OF THE INVENTION**

The gripper intended by the invention has the purpose of correcting these disadvantages.

According to the invention, the gripper has a modular structure, which comprises a central profile section core whose dimension is fitted to the size of the piece to be transported, and of profile sections fitted in order to be affixed perpendicularly onto this central core, mechanisms for affixing these profile sections at the selected location, ball and socket bearings mounted at the ends of these profile sections, air chokes that are affixed to the ends of the ball joints and ball joints that enable an angular clearance of the air chokes.

Based on these characteristics, a prototype of the piece to be transported is no longer necessary, since the gripper can be designed from a digitized tape of the piece. The sizeable number of standard pieces makes it possible to assemble it in only about ten minutes by virtue of its modularity. In addition, adjustment can be done in three dimensions. In this way, it is possible to grip pieces having awkward and complex shapes.

According to the invention, the gripper may also include the following characteristics. The central core may be profiled in such a way so as to make it possible to laterally clamp suction pipes for the air chokes. The mechanisms for affixing the profile sections to the central core may consist, for each profile section, of an angle bracket and a small plate that allow the profile sections to become affixed to any position of the central core. Each air choke may be supported by a ball joint mounted in a ball and socket bearing, giving the assembly a specified clearance, for example, of 22 degrees, thus making it possible to transport pieces having awkward shapes. The air choke may be supported by a combined ball joint mounted in a ball and socket bearing, giving the assembly an angular clearance of 30 degrees, and having different lengths that serve as the extension pieces. The air choke may be supported by a piece in the shape of a ball joint whose axis is mounted with a spring, and which is mounted in a ball and socket bearing, giving the assembly an angular clearance of 22 degrees.

Further, the gripper may comprise a ball and socket bearing fitted in order to mount the ball joints there and of ball joints that are fitted with springs as well as combined ball joints, thus making possible an angular clearance of approximately + 22 degrees in the two first cases, and of 30 degrees in the last case, where their attachment

onto the corresponding profile section makes it possible to make the assembly slide until the desired position along the profile section, or extension pieces and combined ball joints that make it possible for the air chokes to be able to suction by vacuum the pieces whose shapes or differences in height are sizeable. The gripper may comprise sloped shims that make it possible to increase the angle by 15 degrees in one case and 35 degrees in a second case. The gripper may be fitted in order to be affixed onto a robot or on a mechanized system by means of a manual interface, in order to allow an effective clamping of the gripper with a large amount of rigidity, or it may be adapted in order to be affixed onto a robot or on a mechanized system by automatic interfaces with a large amount of clamping rigidity. The gripper may be mounted onto a crosspiece that is itself mounted either onto a robot or onto a mechanized system, and that accommodates three interfaces that make it possible to mount a gripper to the center for small pieces to be transported, or to each end for the pieces that have large dimensions.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in reference to the attached drawings which show it in possible different embodiment modes.

Figure 1 is a perspective view of an embodiment form of a modular gripper according to the invention.

Figures 2 and 3 are transverse section views of the profile sections that can constitute a central core of the gripper according to the invention.

Figure 4 is a transverse section view of a profile section that can be attached perpendicularly to the central core of the gripper.

Figure 5 is a perspective view of a joint for attachment of a profile section to the central core.

Figure 6 is a perspective view of an angle bracket for attachment of a profile section to the central core.

Figure 7 is a perspective view of a ball and socket bearing support.

Figure 8 is a perspective view of a ball joint.

Figure 9 is a longitudinal section view of a ball joint fitted with a spring according to a second embodiment mode.

Figure 10 shows a ball and socket bearing equipped with an air choke.

Figures 11 and 12 show an extension piece and a sloped shim, respectively.

Figure 13 shows a small plate;

Figure 14 is a perspective view of the manual interface between the gripper and a robot or mechanized system (not shown).

Figure 15 is a sectional front view of a ball joint fitted with a spring, of its air choke and its bearing.

Figure 16 is a front view of a flat angle mounting bracket.

Figure 17 is a transverse section view of another profile section core 80 of the gripper.

Figure 18 is a perspective and partial section view of the profile section, of a ball and socket bearing, of a ball joint fitted with a spring, and the associated air choke.

Figure 19 is view similar to Figure 18 according to another embodiment form of the ball joint.

Figure 20 is a front view similar to Figure 19 showing another embodiment variation.

Figures 21 to 23 are perspective views of automatic interfaces between the modular gripper according to the invention and a robot or an automated system (not shown).

Figure 24 is a perspective view of a crosspiece equipped with three interfaces with grippers according to the invention.

Figure 25 is a front view of a ball joint combined with an extension piece.

Figures 26 and 27 show plates for arms bent at an angle vertically.

Figure 28 is a perspective view in a reduced scale of a gripper equipped with plates of Figures 26 and 27.

Figures 29 and 30 show plates for arms bent at an angle horizontally.

Figure 31 is a perspective view in a reduced scale of a gripper equipped with plates of Figures 29 and 30.

## DESCRIPTION OF PARTICULAR EMBODIMENTS

The gripper shown in the drawings is made of a modular structure, which includes a central profile section core 1 (Figs. 2 or 3) whose dimensions are fitted to the size of the piece to be transported, and of at least one profile section 2 (Fig. 4) fitted in order to be attached perpendicularly onto this central core 1.

As shown on Figure 1, the central profile section core and the profile sections have cross-sections that remain substantially the same over their length.

As shown on Figures 2-4, the central profile section core and the profile sections each have two longitudinal planes of symmetry (respectively 10 and 11, 20 and 21, and

30 and 31), substantially perpendicular to each other, and comprises two opposed lateral grooves (respectively 12 and 13, 22 and 23, and 32 and 33) having openings oriented along one (respectively 10, 20, and 30) of these planes of symmetry and two additional opposed lateral grooves (respectively 14 and 15, 24 and 25, and 34 and 35) having openings oriented along the other (respectively 11, 21 and 31) of these planes of symmetry. As is visible in the Figures, each of the grooves has a maximum transverse width larger than a width of its opening.

The two lateral grooves 34, 35 of the profile section of Figure 4 make it possible to clamp there, on each side, a pipe, for example, of the size 5.5 x 8. The same possibility exists for opposed lateral grooves 14, 15 and 24, 25 of the profile sections of Figures 2 and 3, whose geometry can be modified approximately in order to allow the grooves to clamp, for example, 5.5 x 8 pipes there from two sides. The other grooves are for attaching air chokes as described in details below.

As shown on Figure 1, the gripper also includes mechanisms 3 for affixing these profile sections 2 at the selected locations, as well as ball and socket bearings 4 on supports 5 mounted on these profile sections 2 (see also Fig. 7 to 10), air chokes 6 that are affixed by air choke supports 7 to the ends of the ball joints (Fig. 10, 15, and 18-20) that enable an angular clearance of the air chokes.

The central core 1 can be made of aluminum. The attachment system 3 consists of a connection piece 3a (Fig. 5) and angle brackets 3b (Fig. 6); it makes it possible to easily adjust the different profile sections of Fig. 4 to the selected locations. The length of the profile sections of Fig. 4 is determined by the position of the air chokes 6 that, themselves, vary according to the geometry of the piece to be transported.



At the end of the profile sections of Fig. 4, ball and socket bearings 4 are affixed through ball and socket bearing supports 5 (Fig. 7) on which simple ball joints 4a (Fig. 8) or ball joints 4a fitted with springs 4b (Fig. 9) or combined ball joints are mounted as needed. The mounting of all of the elements is shown in Figures 10, 15, 18 and 20. The ball and socket bearing supports (Fig. 7) are affixed onto the profile section of Fig. 4 by cooperating with small plates 5a (Fig. 13) that slide inside of the grooves of the profile sections by means of bolts 5b (Fig. 18), and which make thus it possible to provide a supplemental adjustment.

As shown best in Figure 18, the ball and socket bearing support 5 in the shape of an angle bracket extends away from the horizontal plane of symmetry 20 of the profile section 2, such that (i) the ball joint 4a on the ball and socket bearing 4 is placed away from the plane of symmetry 20 of the profile section and (ii) a main central axis 70 of the ball joint on the ball and socket bearing 4 is oriented away from the plane of symmetry 20 of the profile section. Also, it is visible on Figure 18 that the ball and socket bearing support 5 is clamped to the profile section 2 independently from the ball joint 4a.

The two different types of ball joints (Fig. 8 and 9) make possible an angular clearance of approximately + 22 degrees, which makes it possible to refine the final adjustment. The combined ball joints (Fig. 25) allow an angular clearance of approximately + 30 degrees, and, depending on their length, act simultaneously as an extension 7a (Figs. 20, 25). The different types of air chokes are chosen as a function of the space available on the piece to be transported and its weight. There are affixed to the end of the ball joints (Fig. 10, 15 and 18-20).

In case it is necessary to adjust the height, there are several types of extension pieces 8 (Figs. 1, 11) or combined ball joints covering most of the necessary adjustments. In case of awkward pieces that require an angular clearance greater than the one obtained with the ball and socket bearings (Fig.7) and the ball joints (Fig. 8, 9), as well as the combined ball joints, sloped shims 9 are planned (Fig. 1, 12) that make it possible to increase the angle by 15 degrees in one case and 35 degrees in the other case.

The assembly of all of these pieces makes it possible to construct a modular gripper that is capable of meeting all requirements. The specifically designed shapes of the profile sections, as well as the standard assembly of the pieces made of a light metal alloy, make it possible to obtain an assembly having a large amount of rigidity with a relatively low weight. On the three types of profile sections, shapes have been specifically designed in order to clamp two types of suction pipe, which produce a gain in assembly time, and which make it unnecessary to affix them with pipe-collars. All three have been designed in order to receive the small mounting plate (Fig. 13), which makes it possible to only keep in stock a single small plate reference item, and to obtain a good quality of clamping in the profile sections. The inside hole respectively 16, 26, 36 of the profile sections of Figures 2-4 is designed in a manner to be directly threaded in ISO pitches without the necessity for machining.

The modular gripper according to the invention can be affixed onto a robot or onto a mechanized system with the help of a manual interface 50 that is specially adapted for this purpose (Fig. 14) for the profile sections of Figures 2-4. It is also possible to make automatic interfaces 51a and 51b for the profile section of Figure 2 (Figs. 21-22), and 51c for the profile section of Figure 3 (Fig. 23).

The interfaces, by virtue of their monostable clamping at a corner cam of the profile section, allow in all cases a large amount of clamping rigidity and a good repeatability of the positioning precision of the modular gripper.

The profile section made of aluminum in Figures 2-4 has a structure whose shapes have been specifically designed in order to obtain an especially low weight, all while preserving an especially good resistance to torsion and to deflection. Moreover, on two opposite sides of the profile section of Fig. 2, the diameter of the shapes and the width of the intake groove provide the possibility for clamping on one side, a 5.5 x 8 suction pipe, and on the other side, a 4 x 6 suction pipe.

In addition, on the two other sides, the shapes of the slides make it possible to mount the small mounting plates (Fig. 13) which are common to the profile section of Fig. 3 and to the profile section of Fig. 4. This has the consequence that only a single small plate reference item needs to be kept in stock (Fig. 13) and that a good clamping coupling is obtained since a good installation of the screw is made. The diameter of the inside hole of the profile section is provided in order to be tapped directly without additional drilling.

The different attachment pieces (connection piece of Fig. 5, angle bracket of Fig. 6, small plate of Fig. 13) make it possible for the profile section of Fig. 4 to attach at any position selected along the central core, comprised of the profile section of Fig. 2 or of the one from Fig. 3. The air choke is supported by a piece in the form of a ball joint (Fig. 8) that, once mounted in the ball and socket bearing (Fig. 7), gives the assembly an angular clearance of + 22 degrees, thus making it possible to transport pieces with awkward shapes and to refine the adjustments at the last minute (Fig. 10).

The extension pieces (Fig. 11) allow the air chokes to be able to suction by vacuum pieces whose shapes or differences height are sizeable. The automatic interface of Fig. 21 is provided for the section of Fig. 2, while the automatic interface of Fig. 22 is provided for the section of Fig. 3 and the automatic interface of Fig. 23 is provided for the section of Fig. 4.

The design of these interfaces makes possible an effective clamping of the modular gripper by irreversible cam clamping and thus a large amount of clamping rigidity. Moreover, it ensures a good repeatability of the mounting precision, because the clamping is done on the sections, enabling an interchangeability of the grippers in a few seconds.

The modular gripper can be mounted on a crosspiece 52 (Fig. 24) that itself is mounted either onto a robot or onto a mechanized system. This crosspiece accommodates three interfaces 53 specified according to the requirements. This system makes it possible to mount a gripper in the center when small pieces are to be transported, or one to each end for pieces having large dimensions. The specifically designed shapes of the crosspiece allow it to be light while maintaining a good rigidity and while limiting vibrations.

Figures 26-27 show plates f61, 62 or arms bent horizontally that can equip a gripper (Fig. 28). They make it possible to split the central core of the gripper by 60 degrees. They are assembled in a pair: one in the groove of a profile section 4/6 and the other in that of 6/8.

Figures 29-30 show plates 63, 64 for arms bent vertically. These plates, according to their height, function to move the gripper of the piece to be transported in

the direction of the height (Fig. 31). Figure 31 also shows one air choke 6 mounted on a secondary profile section 80 affixed perpendicularly onto one of the profile sections 2 through mechanism 81.



U.S. Serial No. 10/058,075  
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Replacement Sheet

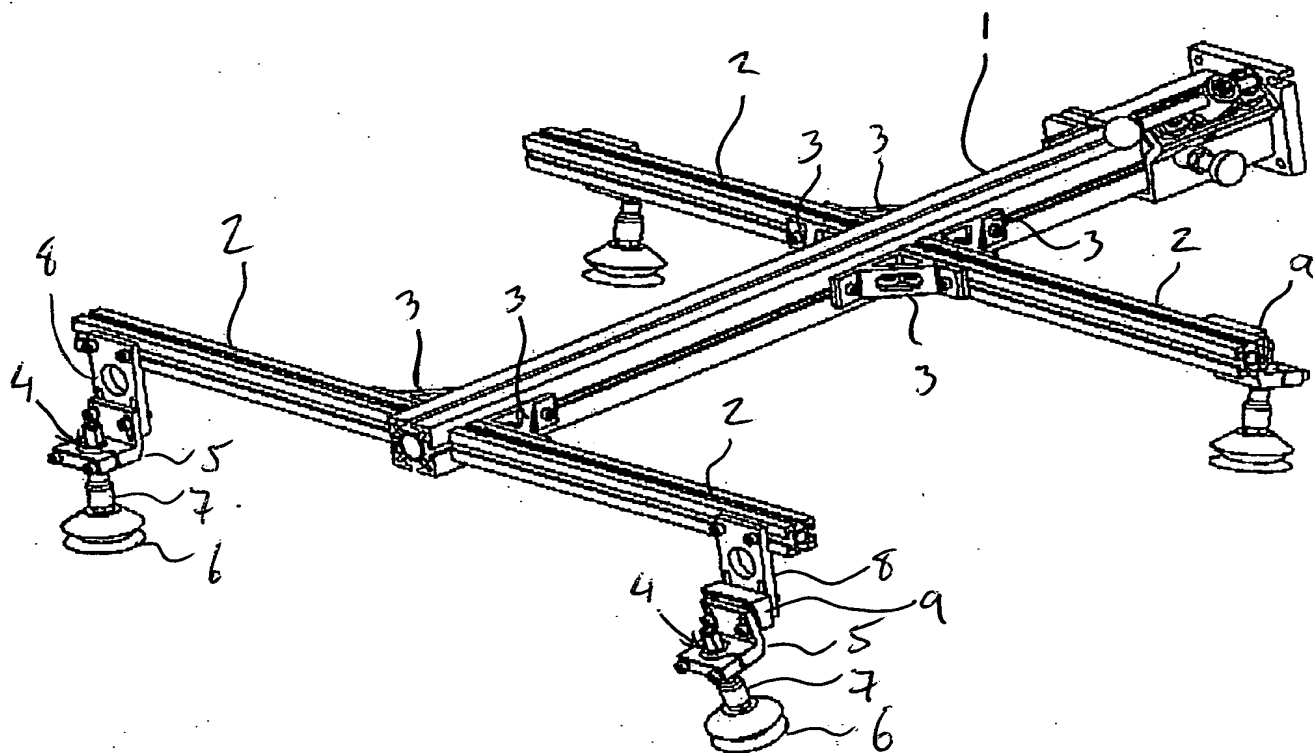


FIGURE 1

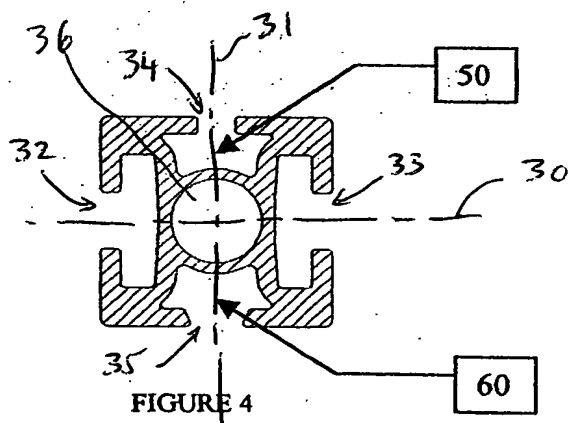
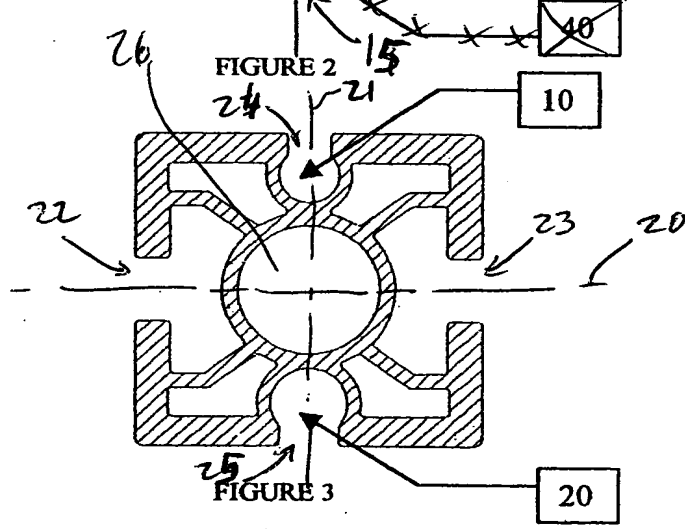
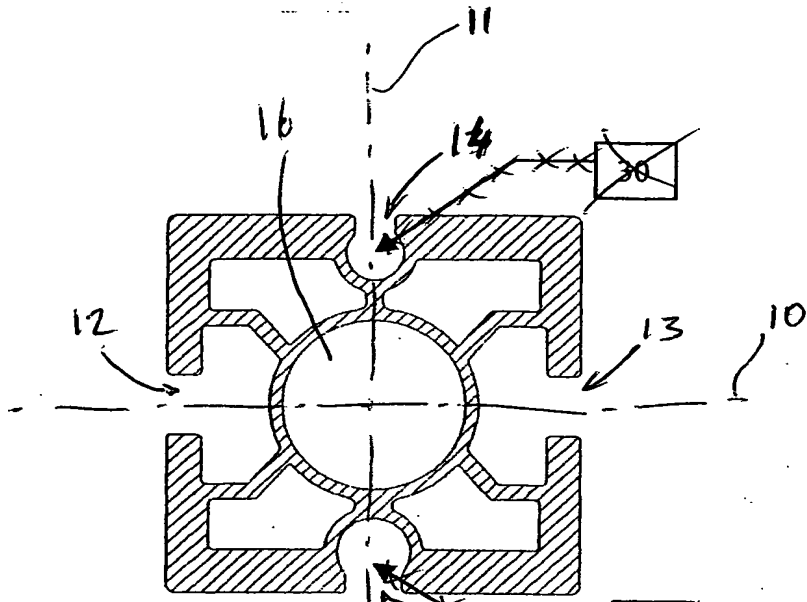


FIGURE 4



U.S. Serial No. 10/058,075  
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Replacement Sheet

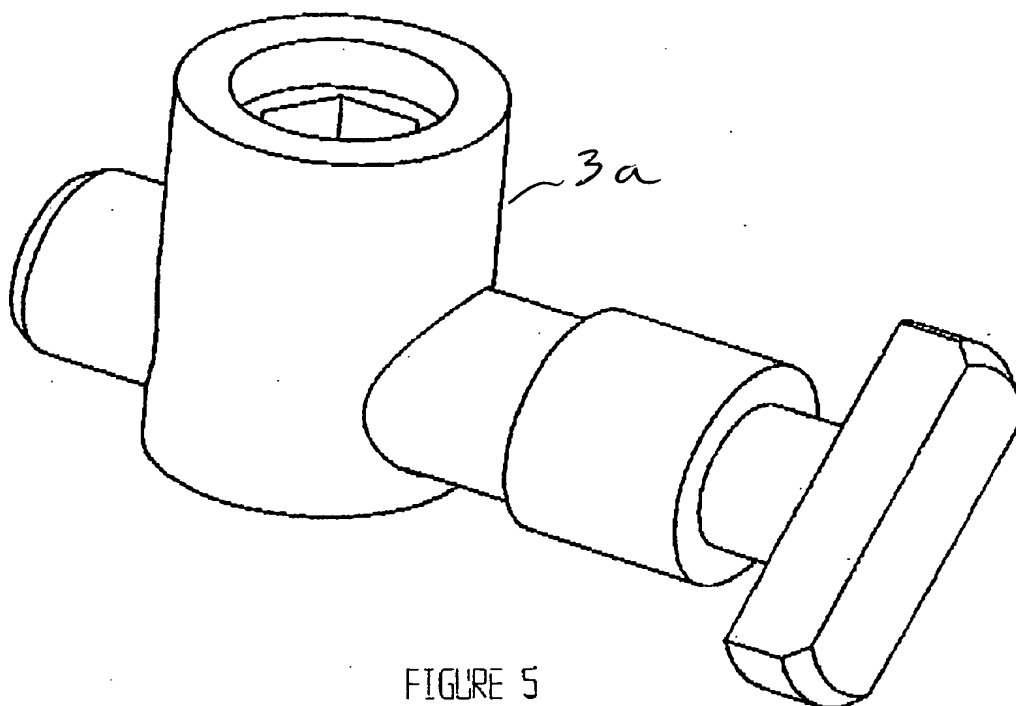


FIGURE 5

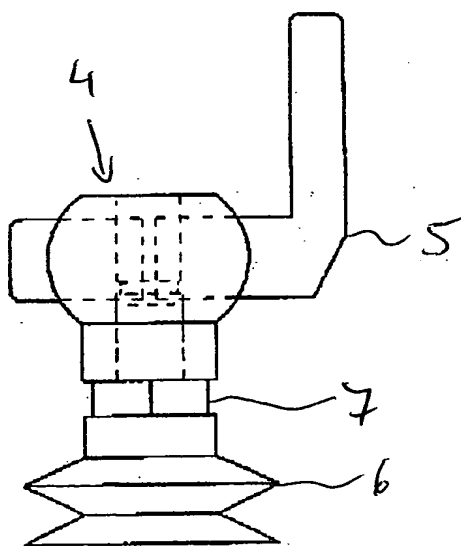


FIGURE 10





U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet

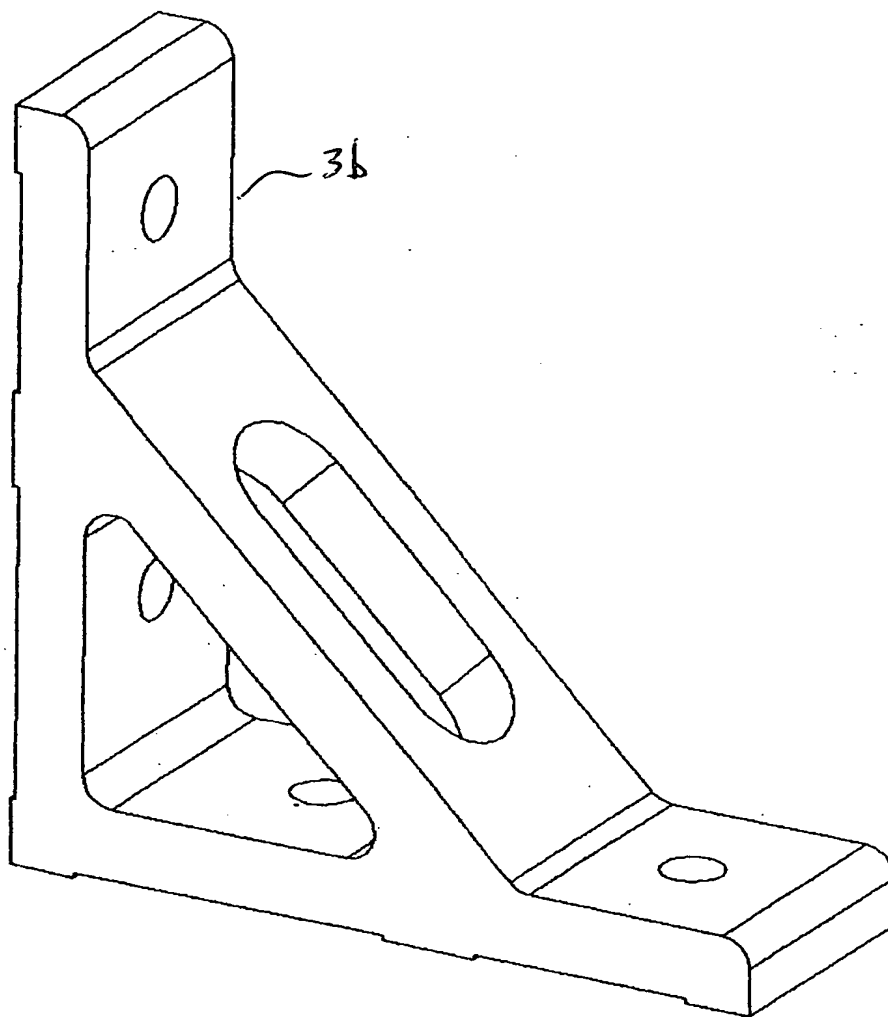


FIGURE 6



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet

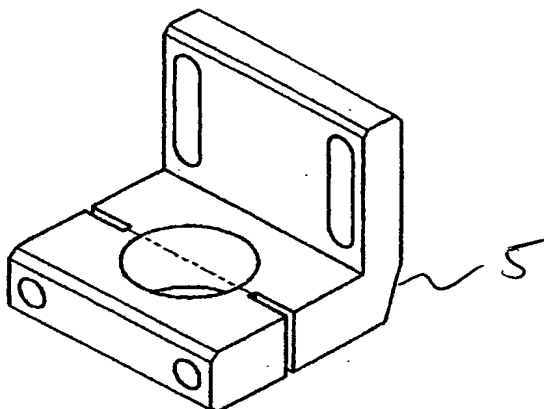


FIGURE 7

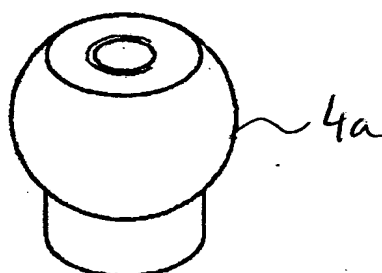


FIGURE 8

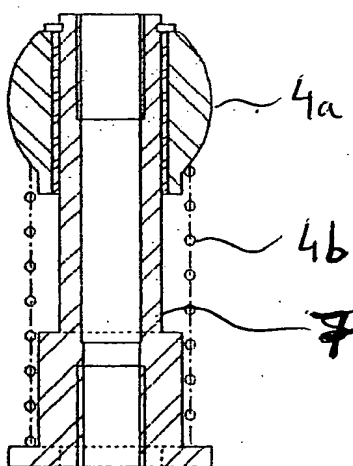


FIGURE 9



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet

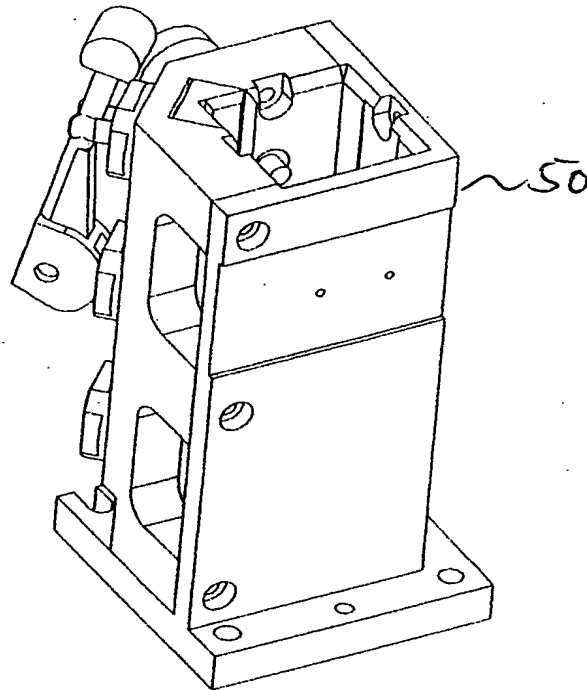


FIGURE 14

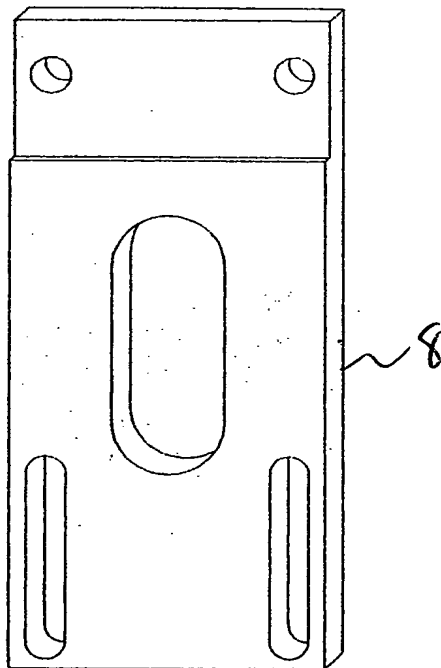
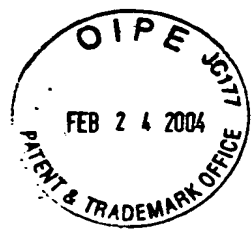


FIGURE 11



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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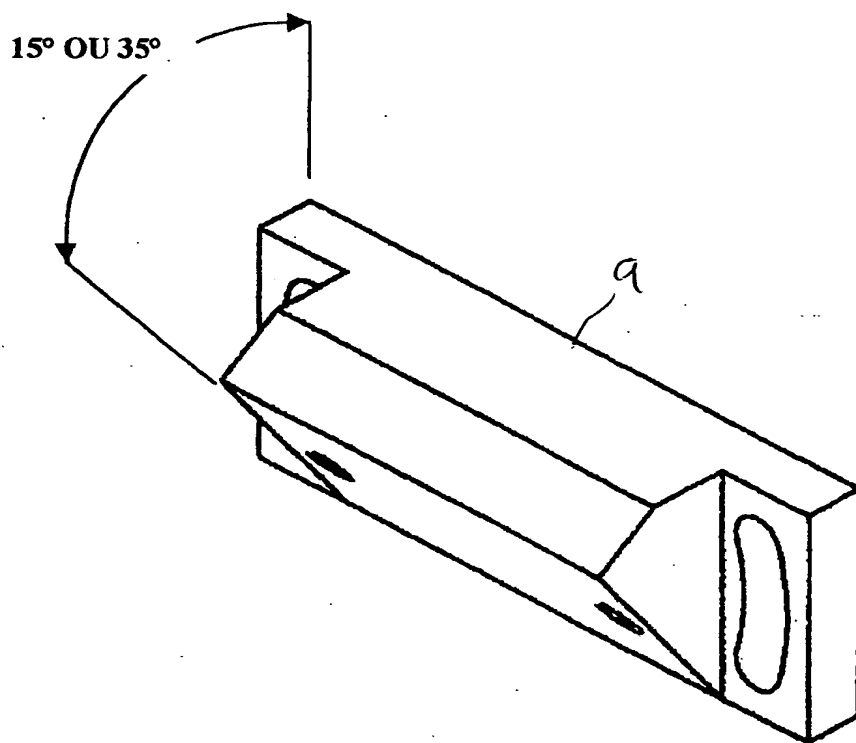


FIGURE 12

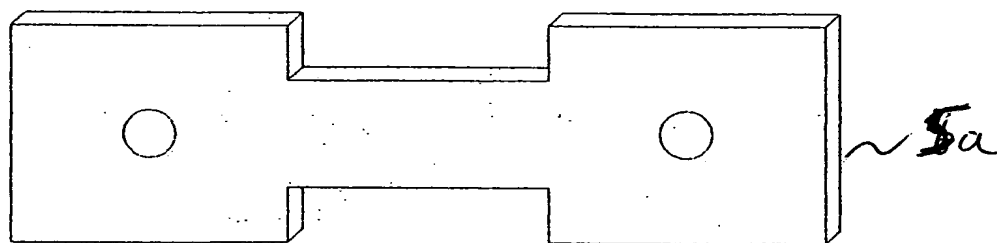


FIGURE 13



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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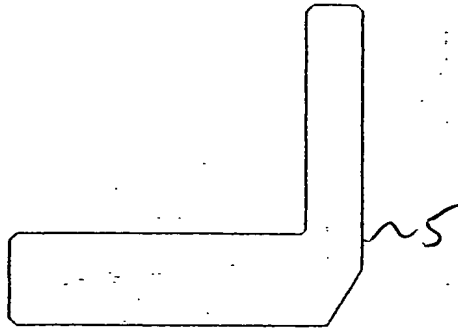


FIGURE 16

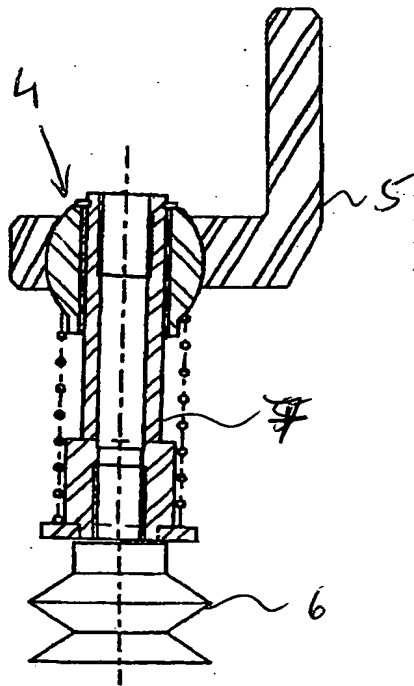


FIGURE 15

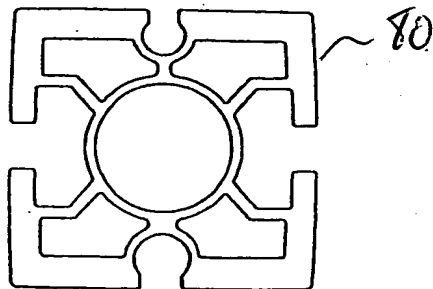
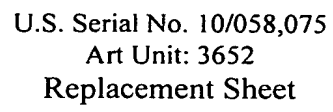


FIGURE 17





U.S. Serial No. 10/058,075  
Art Unit: 3652  
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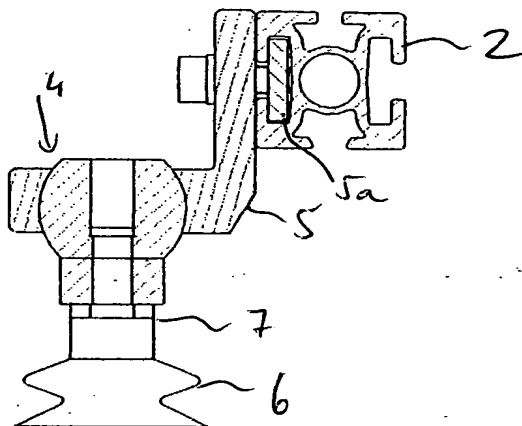


FIGURE 19

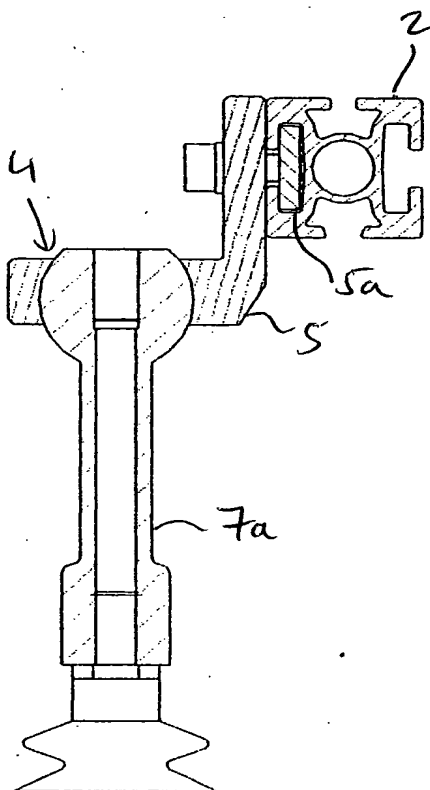


FIGURE 20



U.S. Serial No. 10/058,075  
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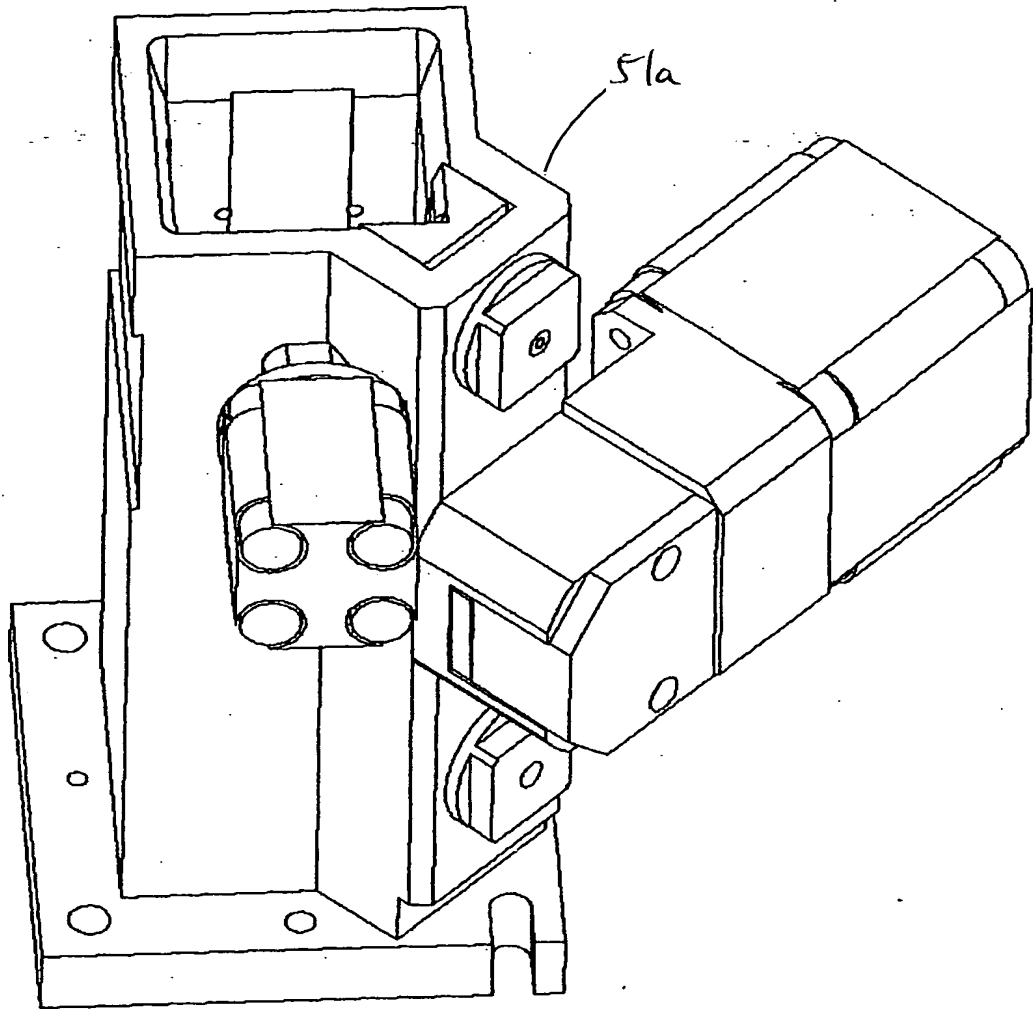


FIGURE 21





U.S. Serial No. 10/058,075  
Art Unit: 3652  
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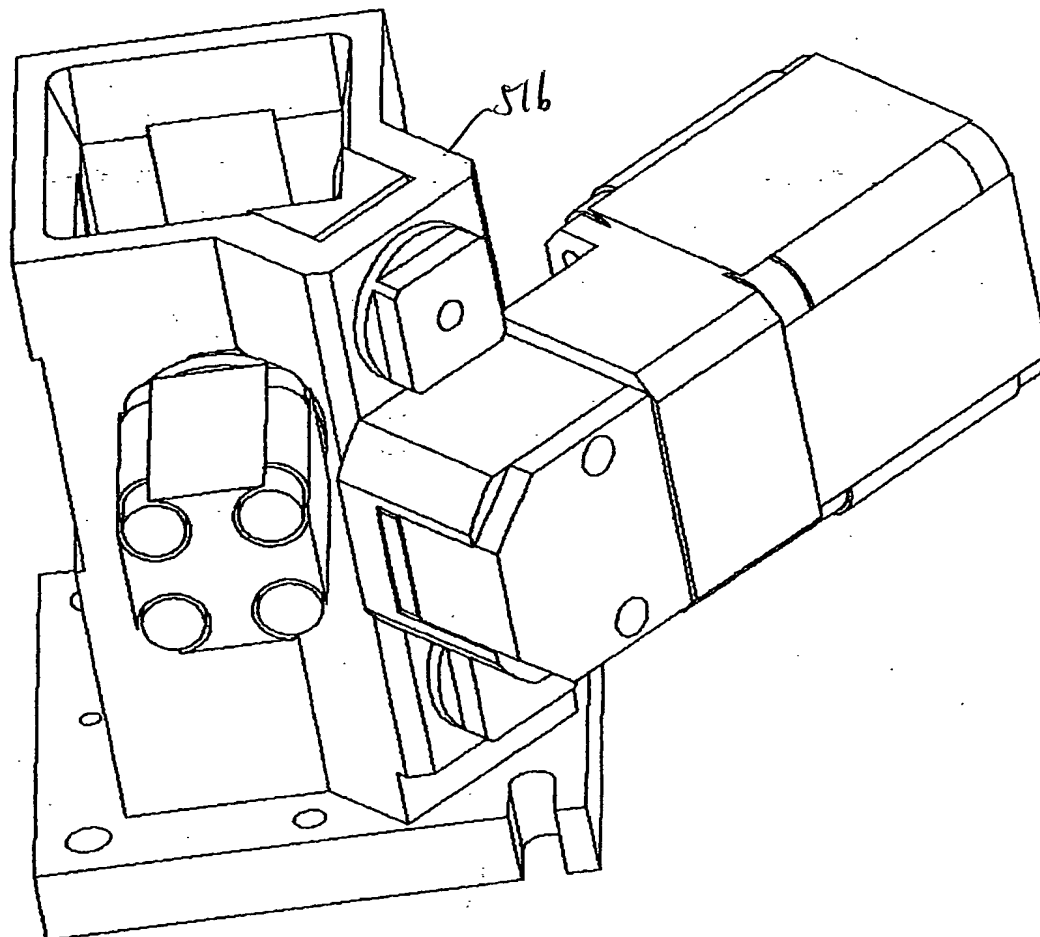


FIGURE 22



U.S. Serial No. 10/058,075  
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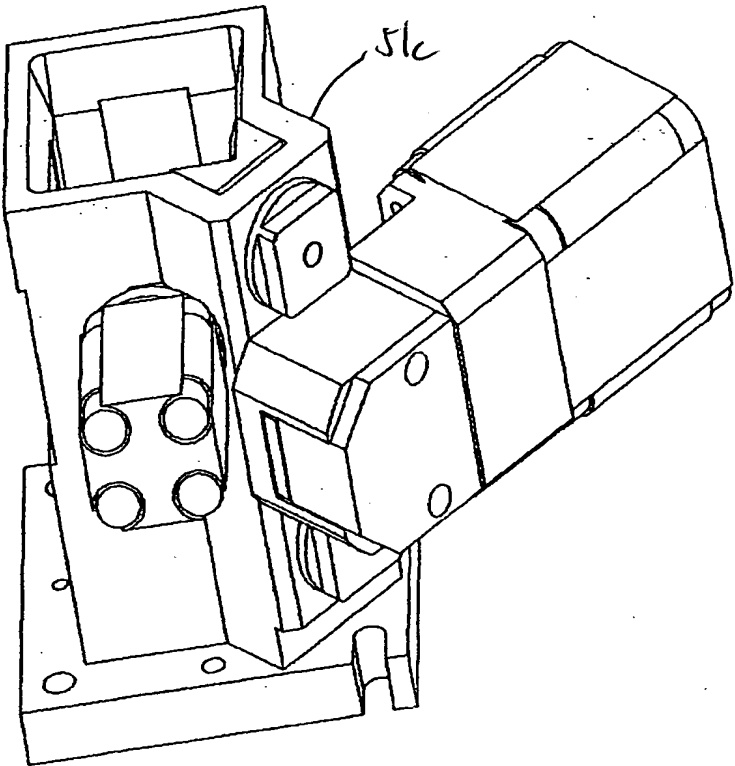


FIGURE 23



U.S. Serial No. 10/058,075  
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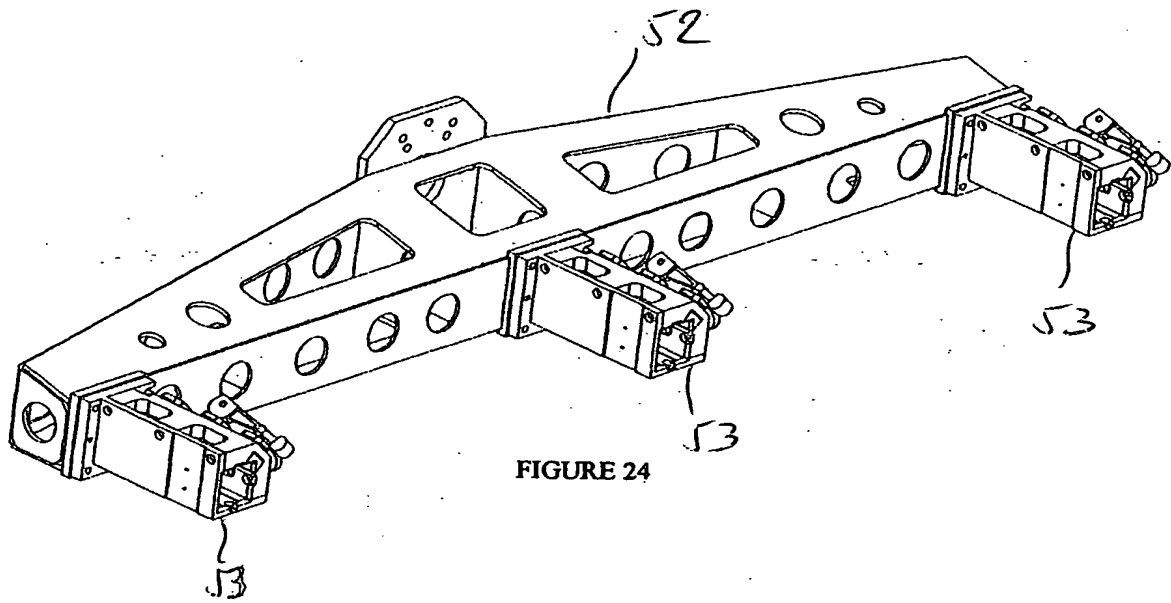


FIGURE 24

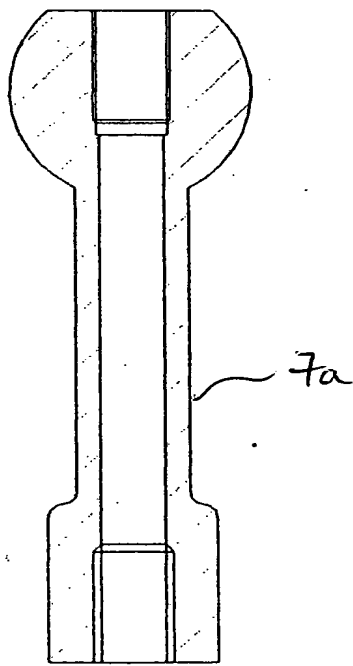
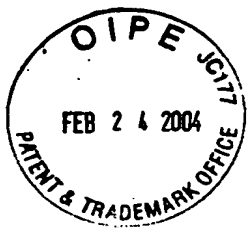


FIGURE 25



U.S. Serial No. 10/058,075  
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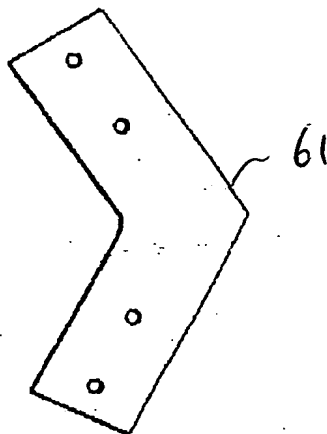


FIGURE 26

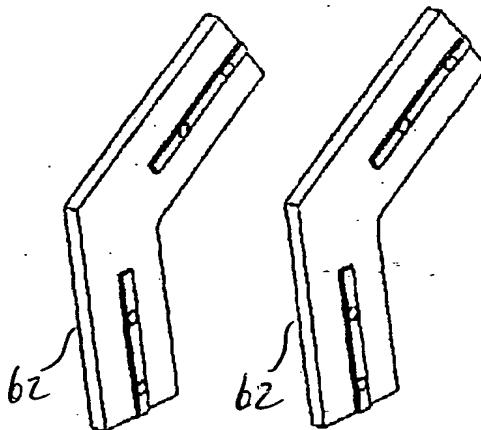


FIGURE 27

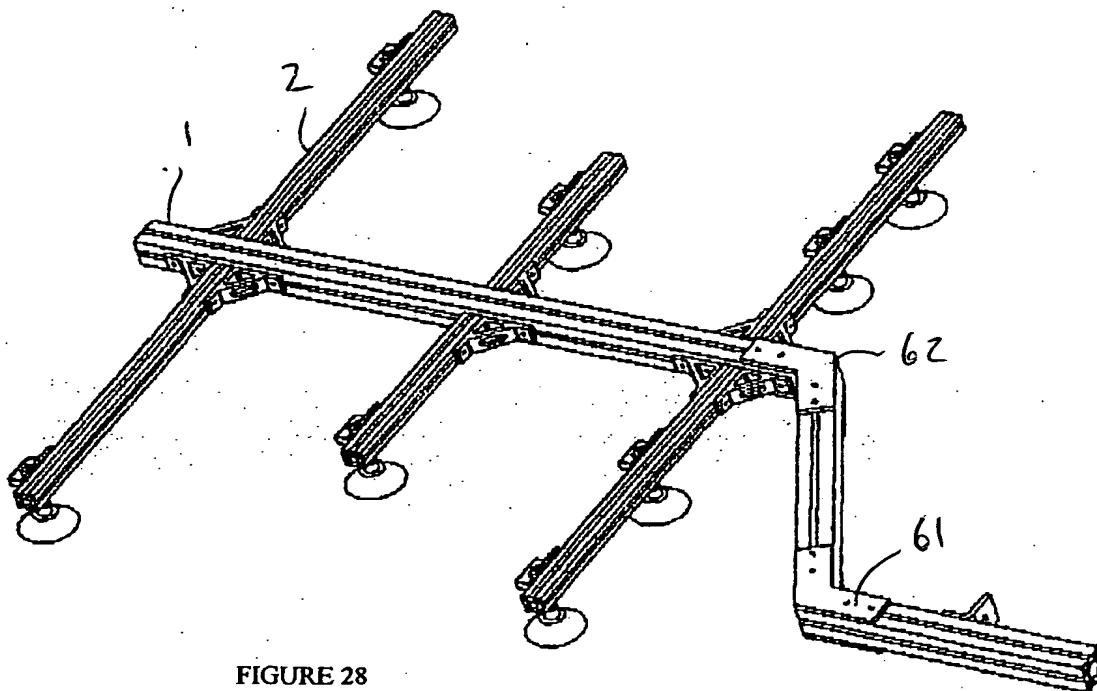
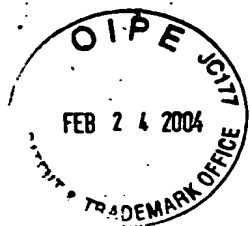


FIGURE 28



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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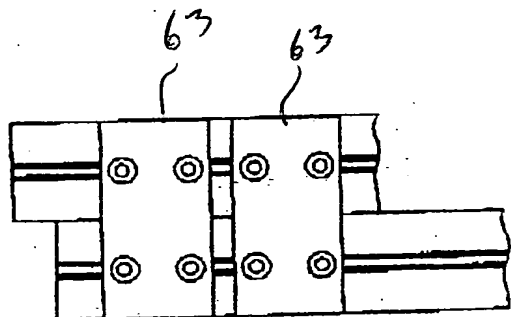


FIGURE 29

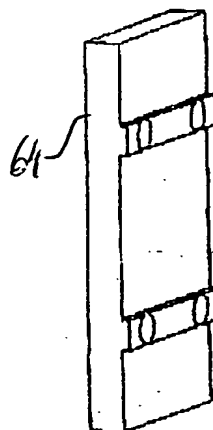


FIGURE 30

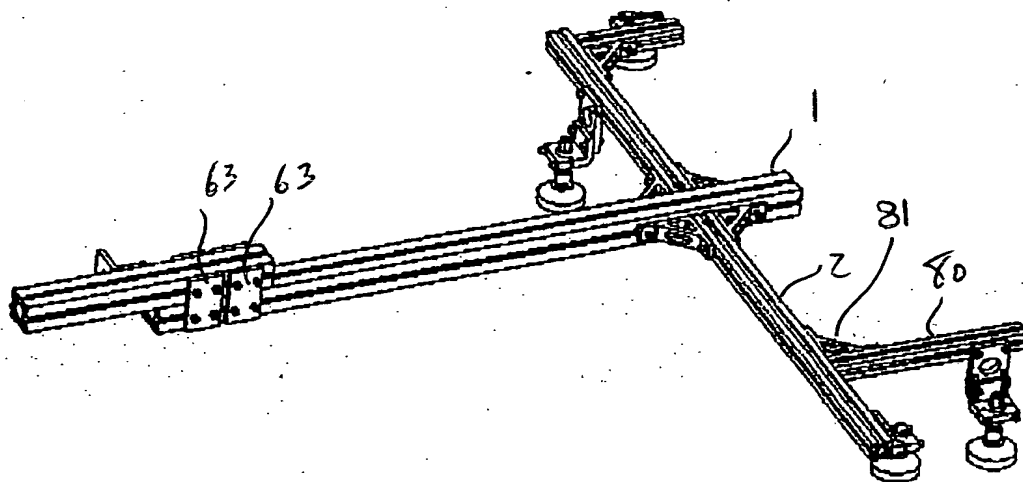


FIGURE 31



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

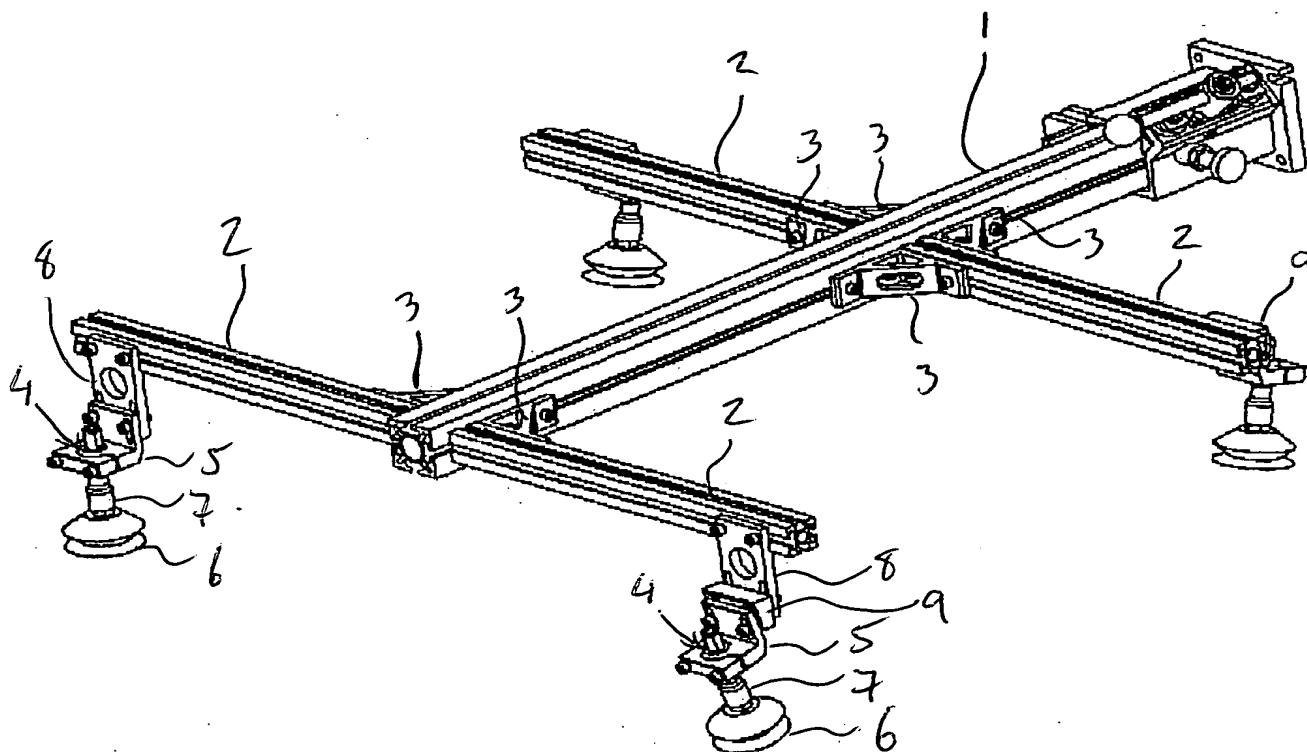
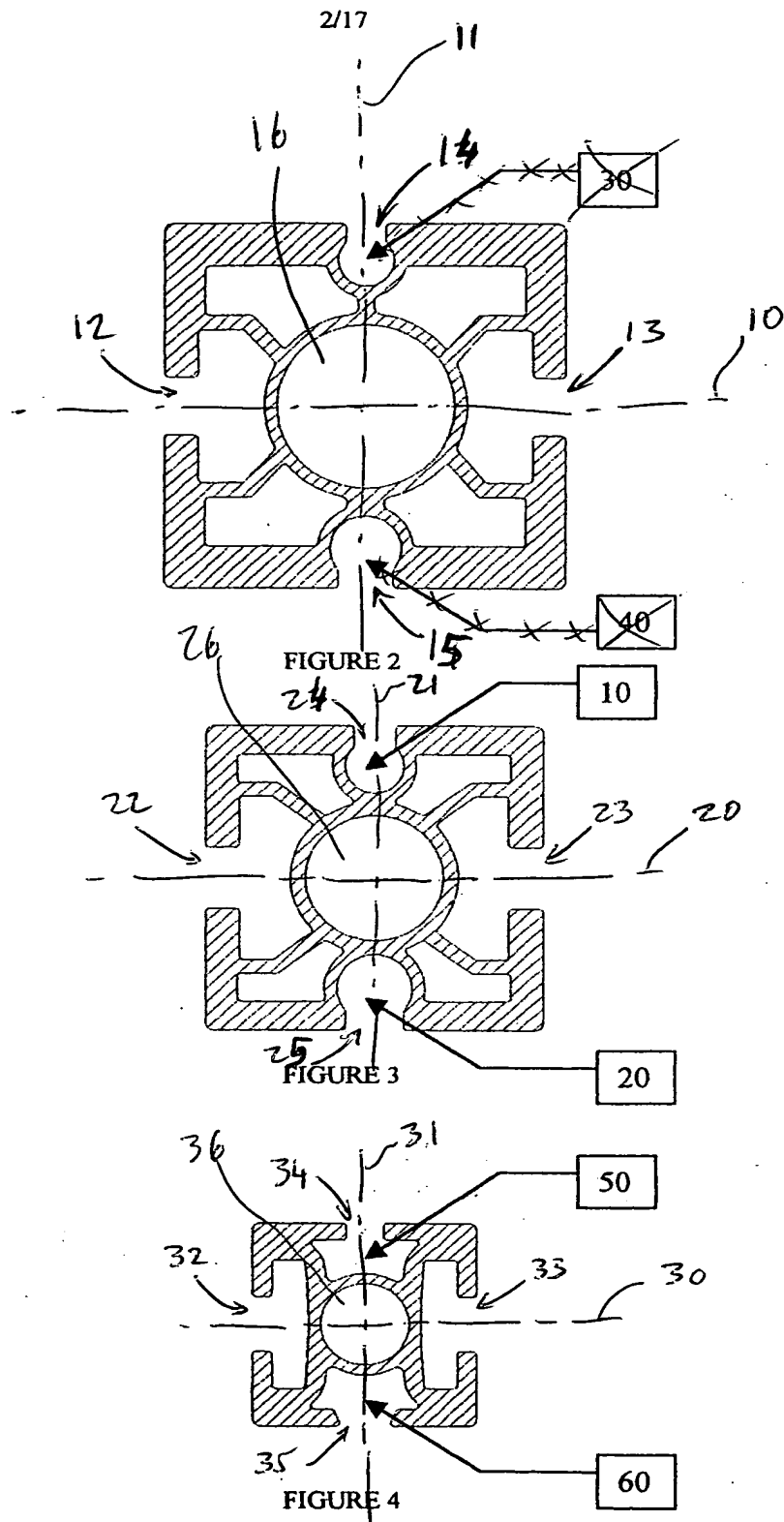
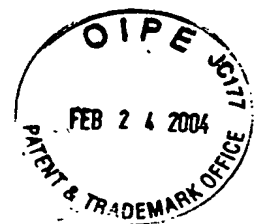


FIGURE 1





U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

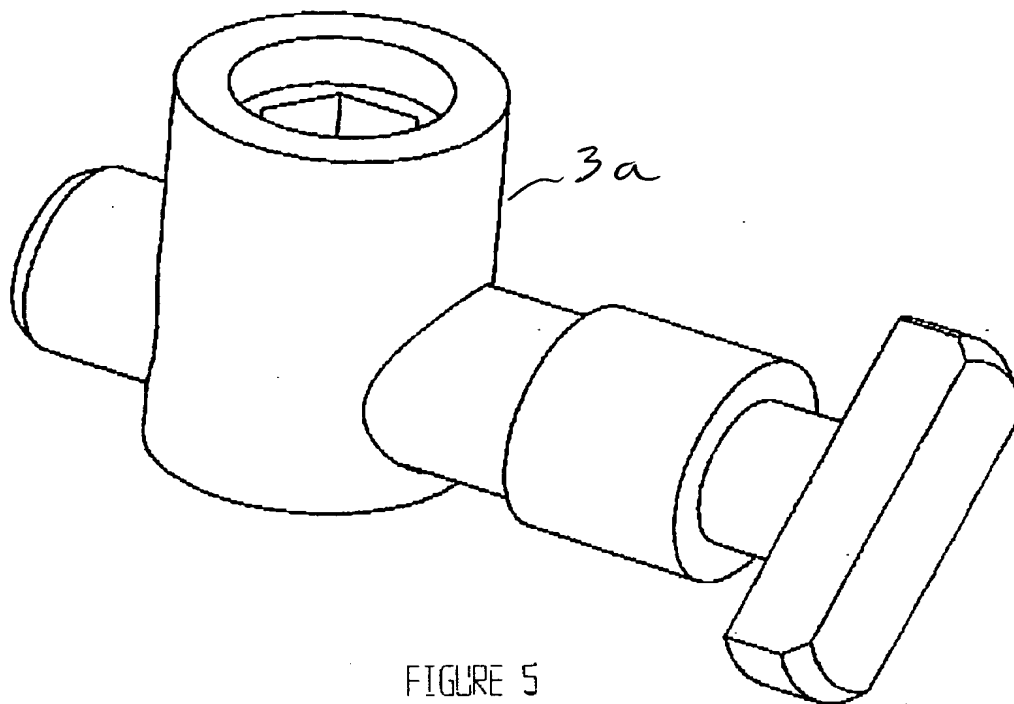


FIGURE 5

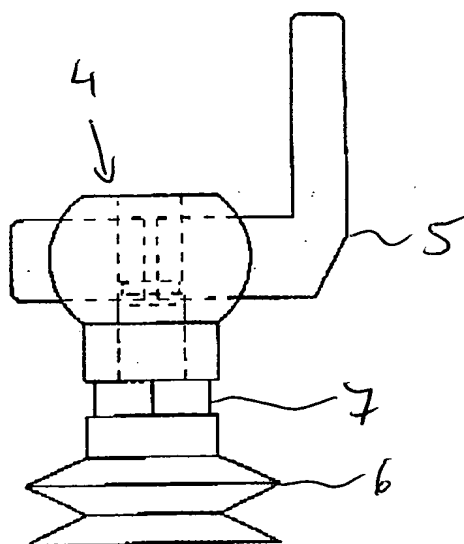
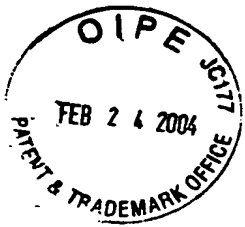


FIGURE 10





U.S. Serial No. 10/058,075  
Art Unit: 3652  
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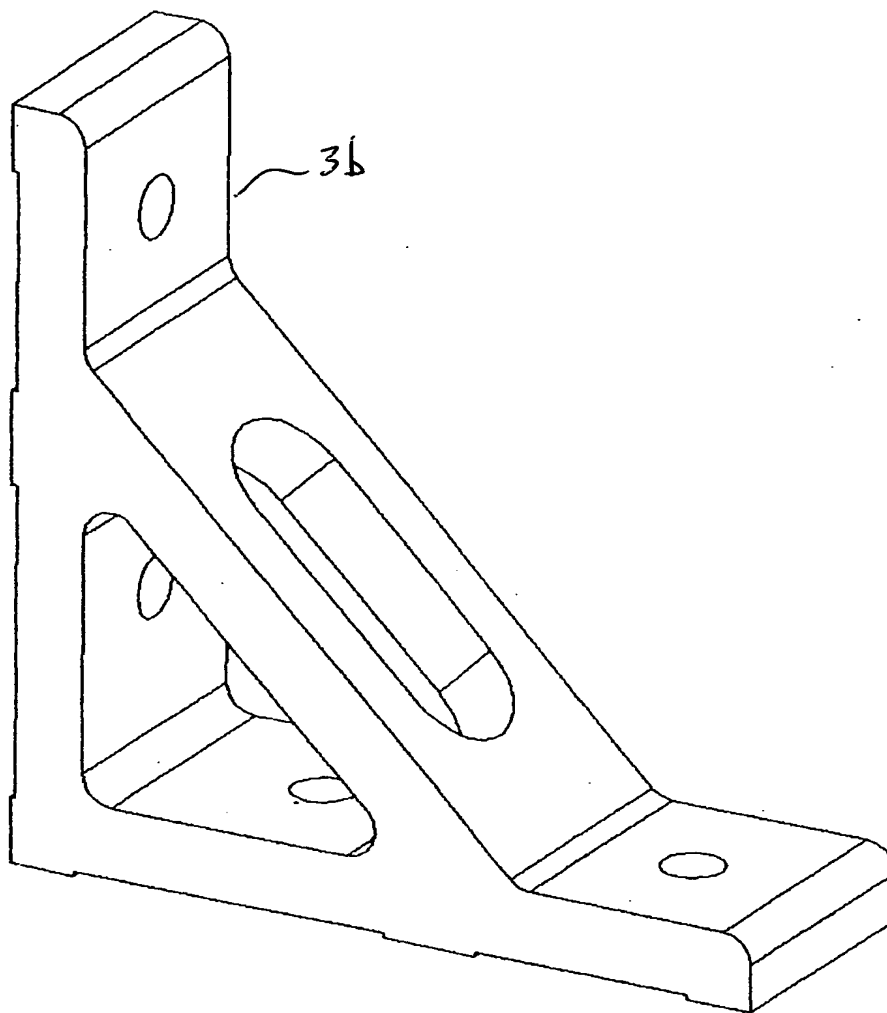


FIGURE 6



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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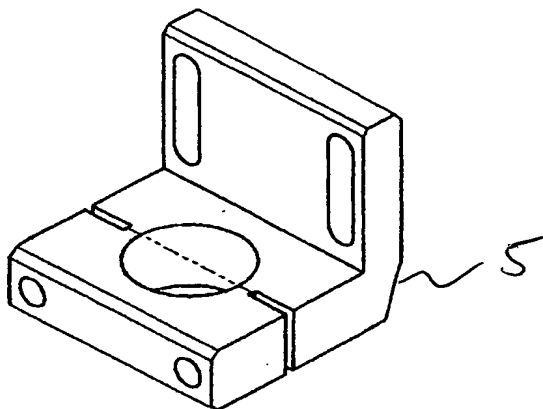


FIGURE 7

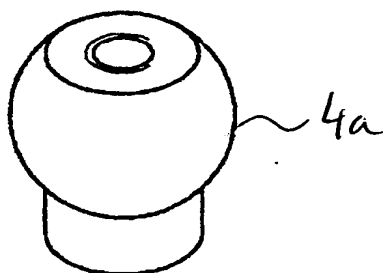


FIGURE 8

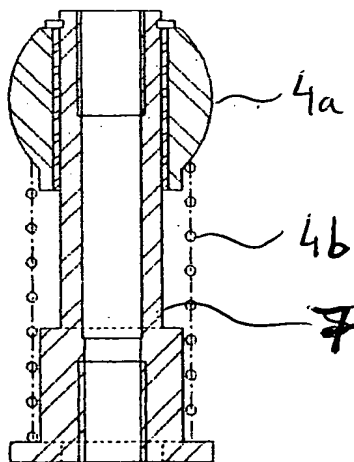


FIGURE 9



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

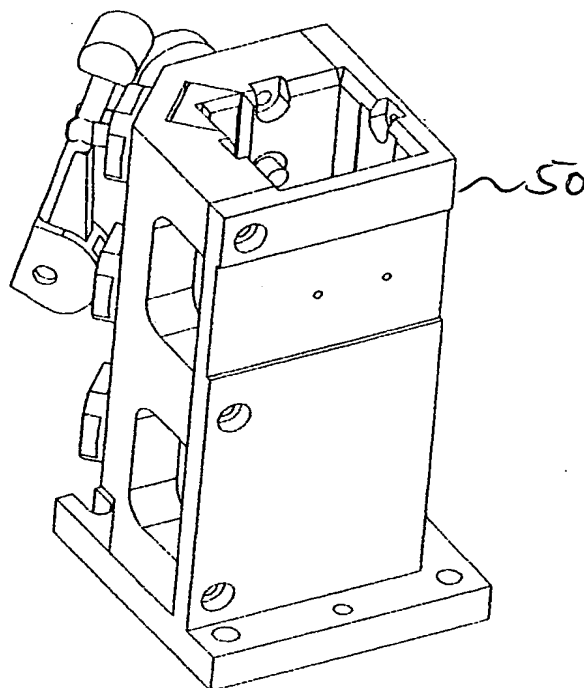


FIGURE 14

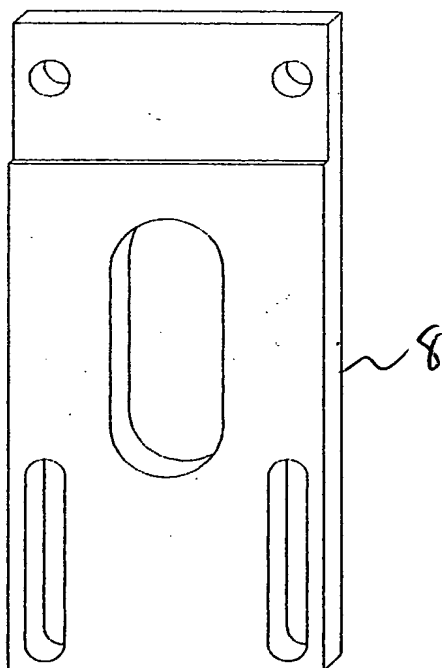


FIGURE 11



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

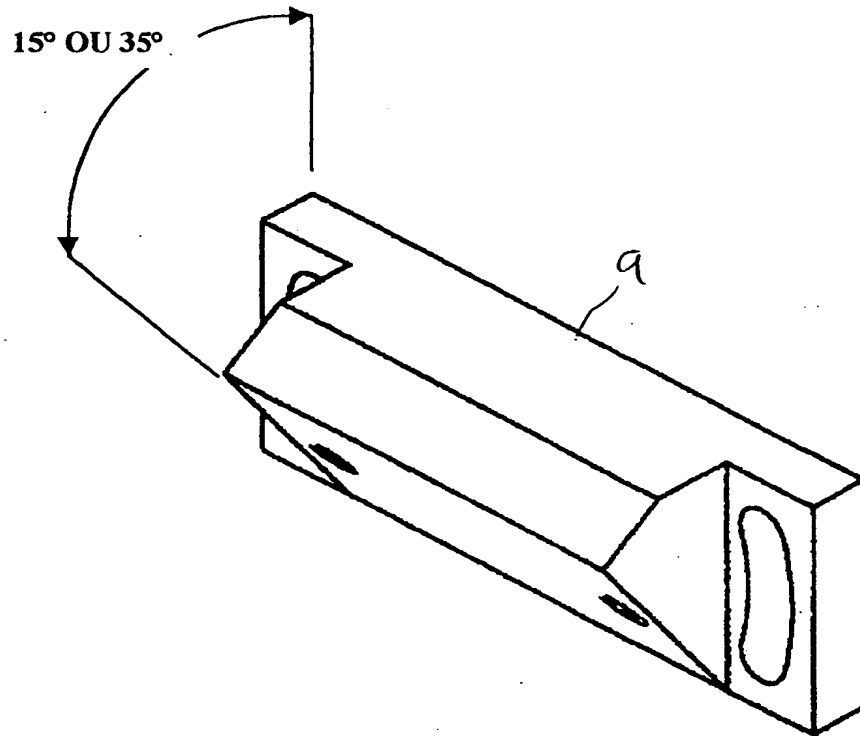


FIGURE 12

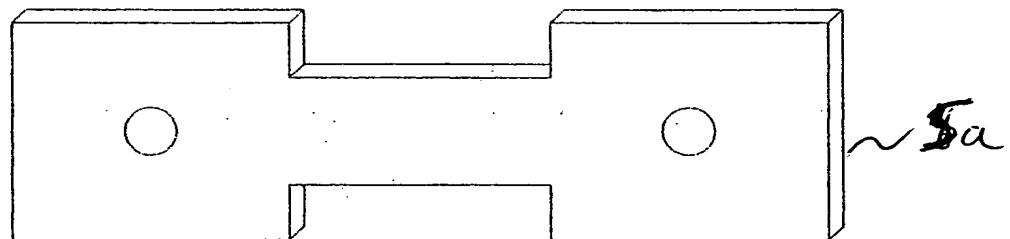


FIGURE 13



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version))

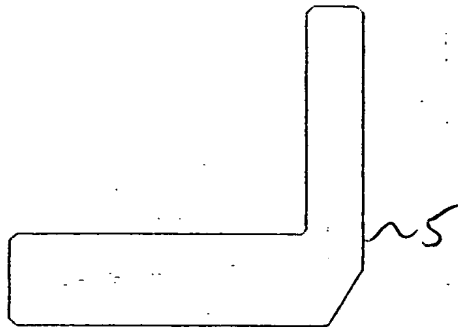


FIGURE 16

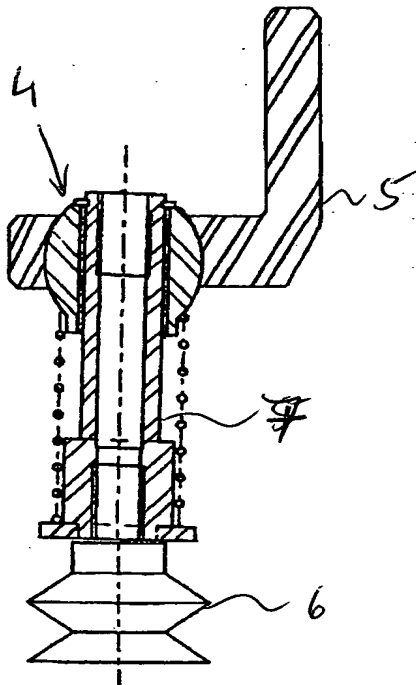


FIGURE 15

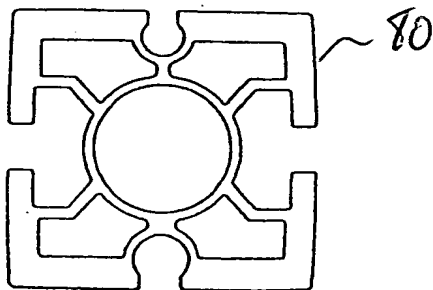


FIGURE 17



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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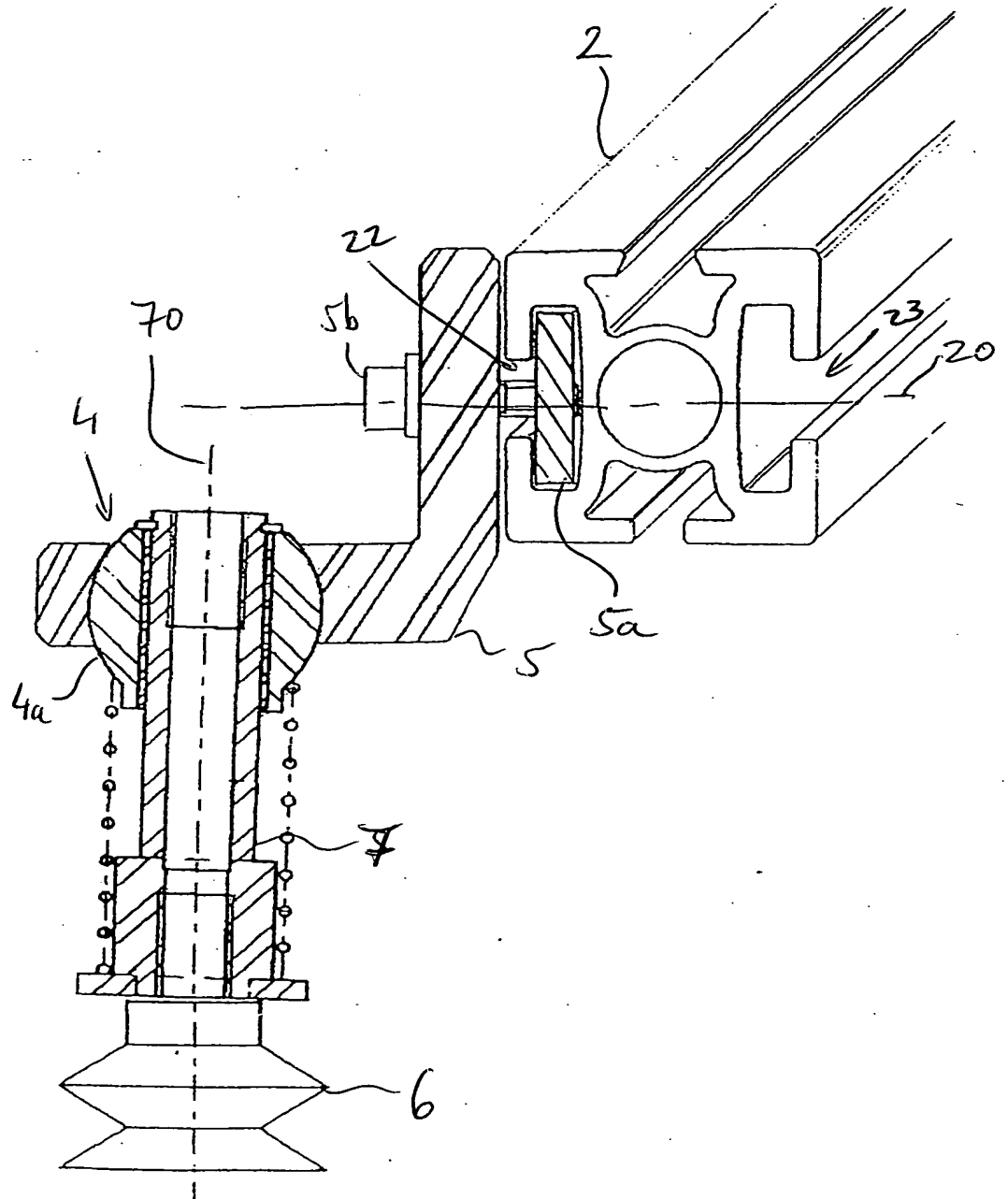


FIGURE 18



U.S. Serial No. 10/058,075  
Art Unit: 3652  
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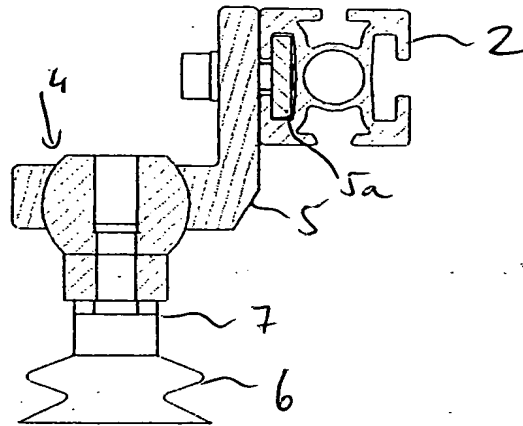


FIGURE 19

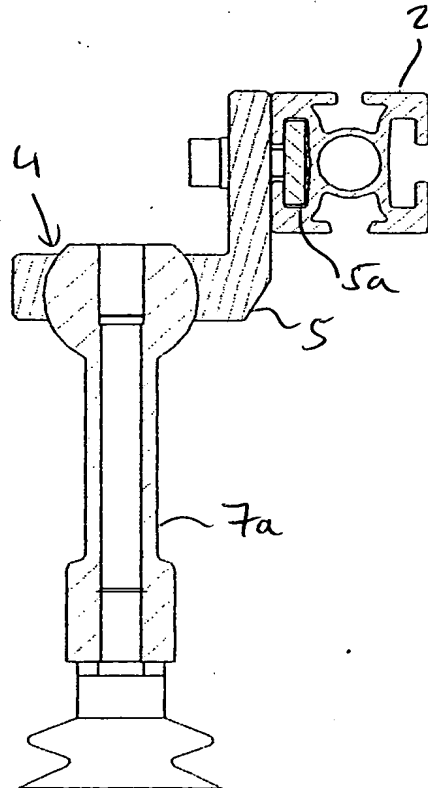


FIGURE 20

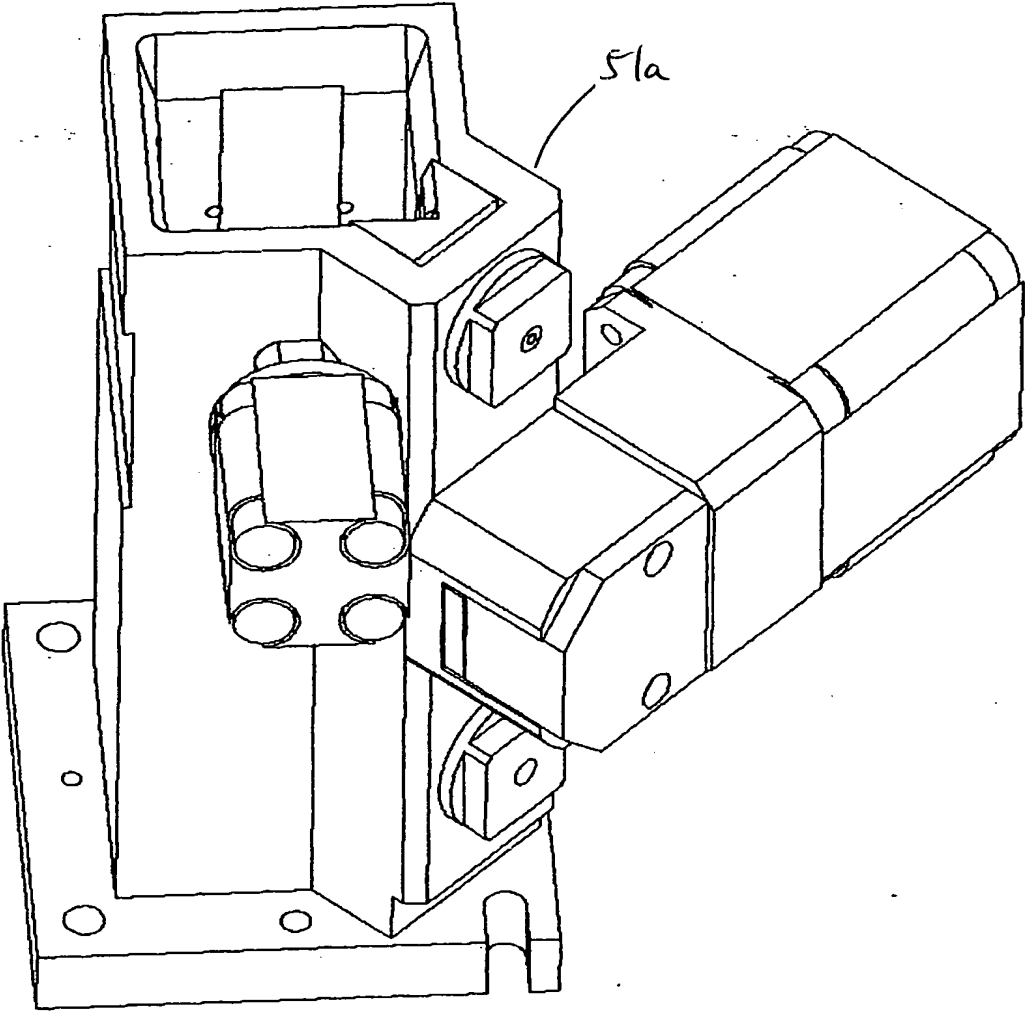


FIGURE 21





U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

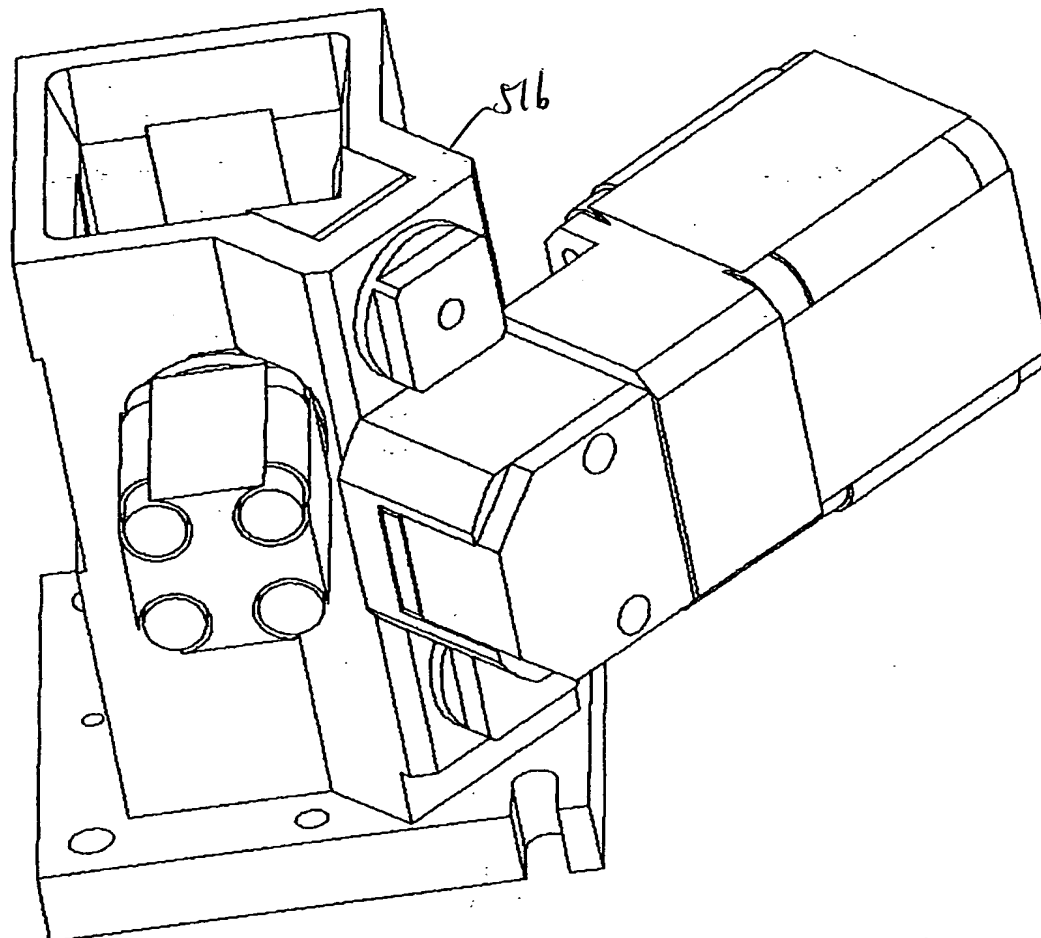


FIGURE 22



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

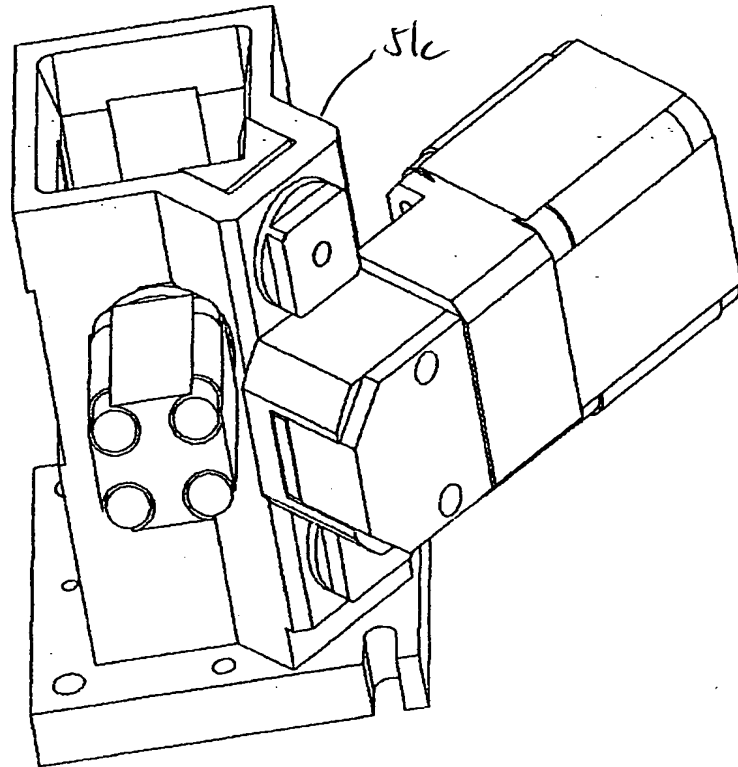
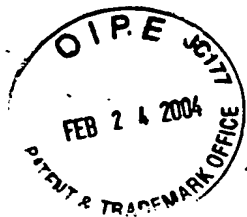


FIGURE 23



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version))

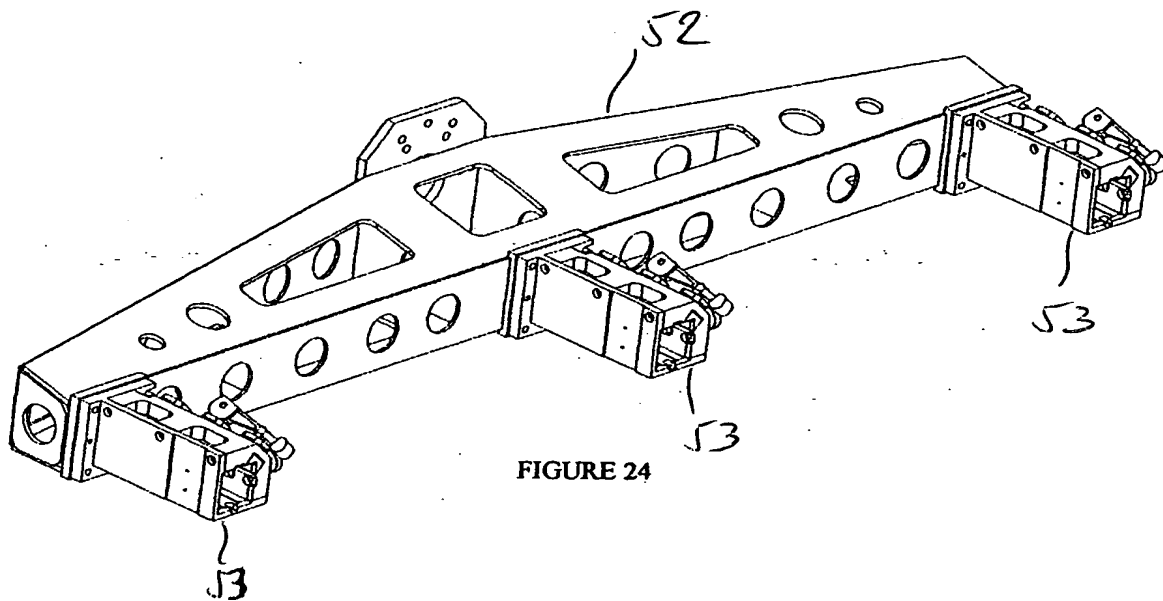


FIGURE 24

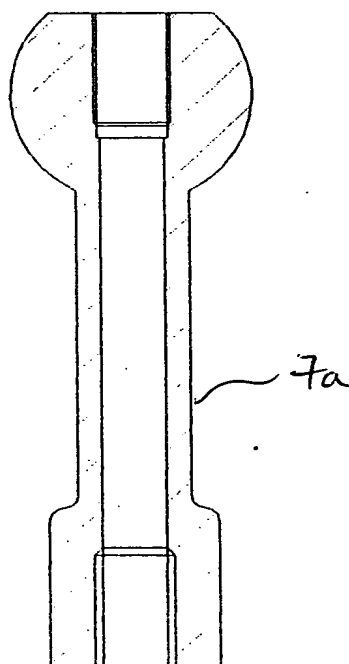


FIGURE 25



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

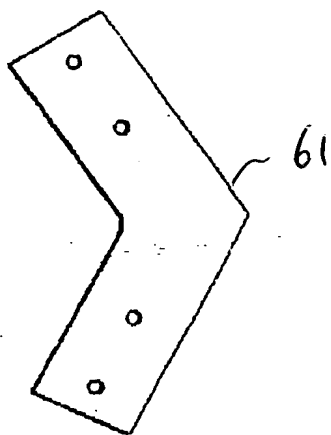


FIGURE 26

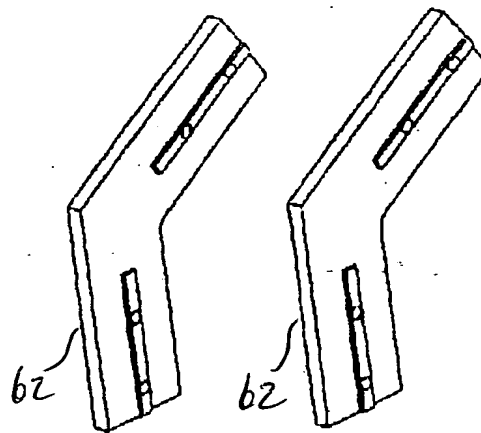


FIGURE 27

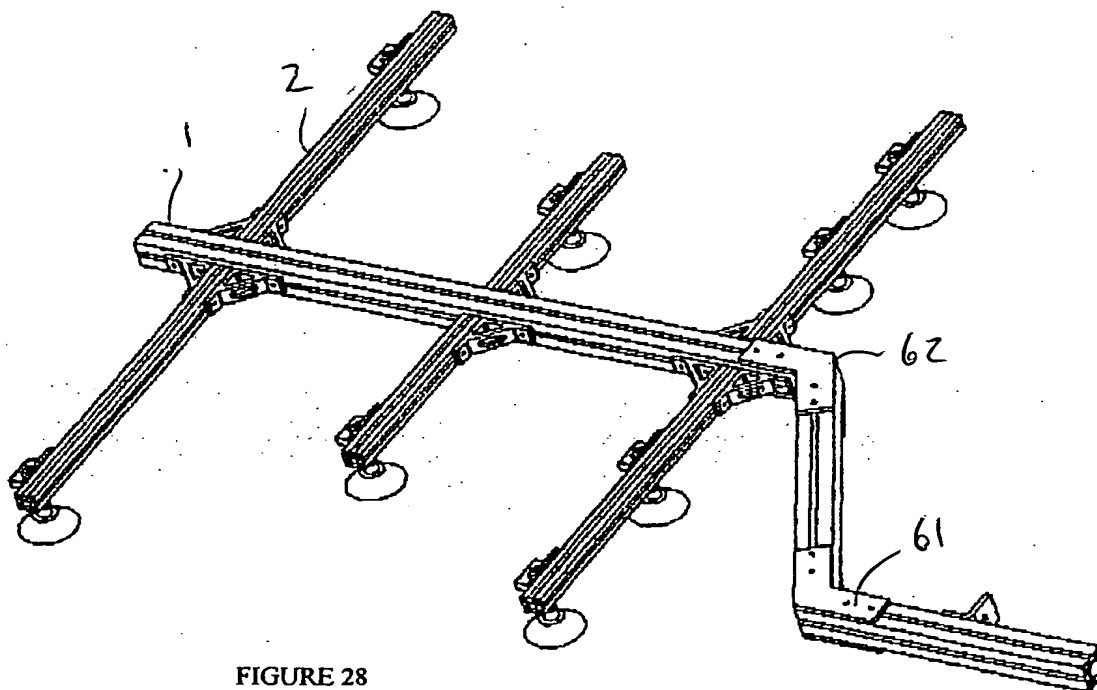
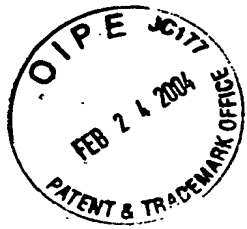


FIGURE 28



U.S. Serial No. 10/058,075  
Art Unit: 3652  
Replacement Sheet (Marked-Up Version)

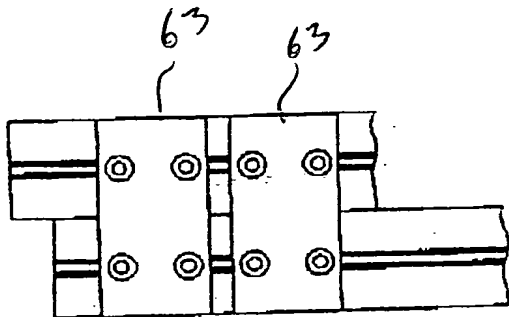


FIGURE 29

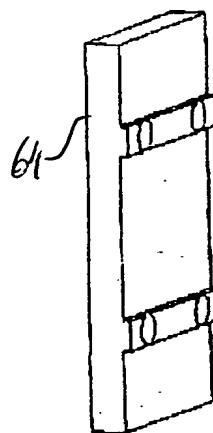


FIGURE 30

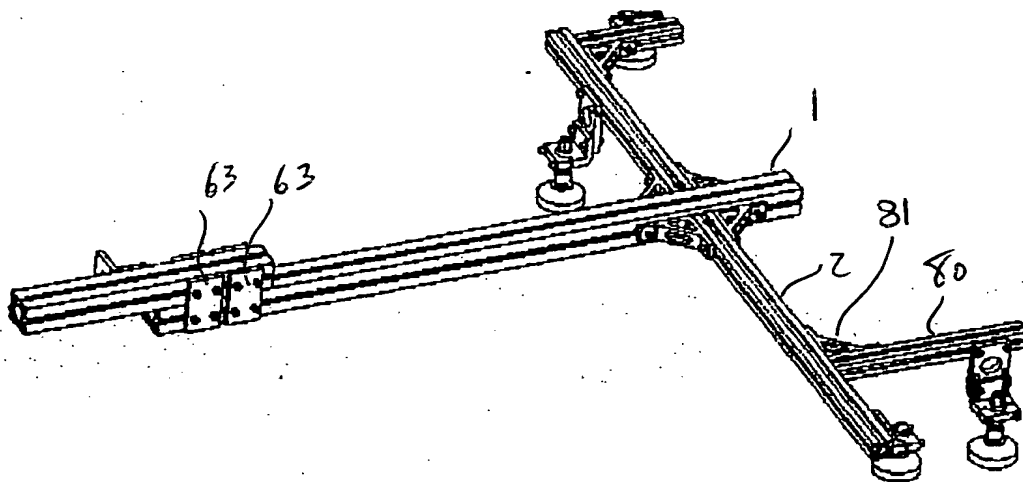


FIGURE 31